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CIVIL ENGINEERING

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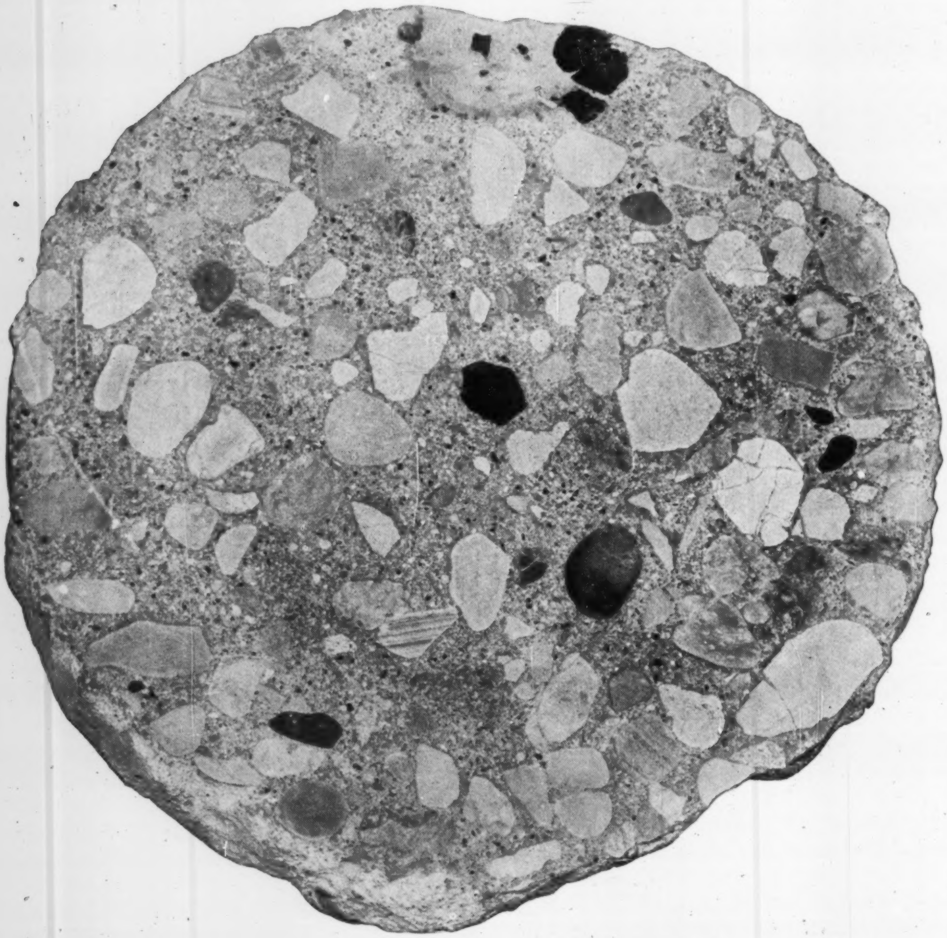
Brock Weymouth

HOOVER DAM IN THE BLACK CAÑYON OF THE COLORADO RIVER

Volume 1 AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 *Number 1*

OCTOBER 1930

MacARTHUR Standard Piles Need No Permanent Casing—Because Good Concrete is Used and Compressed



as shown by this slice, 17" in diameter and 3" thick, cut from a typical MacARTHUR Compressed Concrete Pile driven for the Milwaukee County Court House, Milwaukee, Wisc., *A. Randolph Ross, Architect.*

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We would welcome the opportunity of submitting additional facts.

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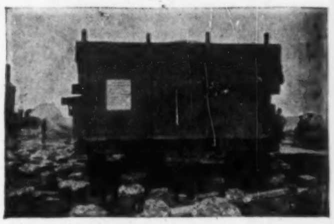
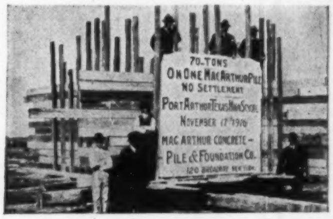


1929 — No settlement with 60 tons on 1 MacArthur Pile. Jersey Central Power & Light Co., So. Amboy, N. J., *J. J. Hyndes, Cons. Supt.*

1919 — At Montreal, 65 tons on one pile caused no settlement. Contract for Montreal Harbour Comms., *F. W. Cowie, Ch. Eng.*



1916 — This 70 ton test made on 1 MacArthur Pile at Port Arthur, Texas. No settlement. *Wm. B. Ittner & Assoc., St. Louis, Archts. and Engrs.*

TONS
ON THREE
PEDESTAL PILES
NO SETTLEMENT

1911 — 102 tons on 3 MacArthur Piles. No settlement. Oregon & Wash'n. R. R. & Nav. Co., Seattle, Wash'n., *J. R. Holman, Eng.*

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Product	*proven*
Experience	*20 years*
Equipment	*latest*
Resources	*unlimited*
Personnel	*capable*
Clientele	*illustrious*
Responsibility	*demonstrated*
Engineering	*sound*
Performance	*100%*
Speed	*record-breaking*

Among Our Writers

J. F. Coleman, President, American Society of Civil Engineers, Director 1915–1917, Vice-President 1918–1919, a southerner, was born in Mississippi and has practiced engineering from New Orleans continuously for more than 35 years.

Elwood Mead, Commissioner of Reclamation, Department of the Interior, is a recognized authority on irrigation economics, and former Director of the Society. He is now directing the construction of the Hoover Dam Project, of all engineering projects undertaken by the United States Government only surpassed in magnitude by the Panama Canal.

Francis Lee Stuart, Consulting Engineer of New York, has served the Society as both Director and Vice-President. His long and varied contacts with railroad engineering problems give weight to his plan for a railroad terminal loop in Manhattan.

Alfred D. Flinn, a past Director of the Society, formerly Deputy Chief Engineer of the Catskill Aqueduct and an authority on municipal water works, has devoted many years to directing the research of Engineering Foundation.

Emory W. Lane spent two years in China as Consulting Engineer for the Kiangsu Grand Canal Improvement Board and the Nantung Shore Protection Bureau. He is now a member of the Advisory Committee for the conduct of the National Hydraulic Research Laboratory, U.S. Bureau of Standards.

William E. Wickenden has been identified with engineering education at Rochester Mechanics Institute, University of Wisconsin, Massachusetts Institute of Technology, for the Western Electric Company, the War Department, the American Telephone and Telegraph Company, and the Society for the Promotion of Engineering Education. He is now President of the Case School of Applied Science.

Alpheus E. Holcomb knows how to move dirt. He has for 30 years been designing, building, selling and servicing earth-moving equipment.

T. Chalkley Hatton, a former Director of the Society, for the past 16 years has been intimately connected with the remarkable pioneering developments in the treatment of the sewage of Milwaukee, both as chief engineer and as consulting engineer.

Frank P. McKibben is considered an authority on structures, having taught Civil Engineering at the Massachusetts Institute of Technology and Lehigh University. He was for a number of years City Engineer of Schenectady.

Henry Wise graduated in 1928 from Rhode Island State College. Since that time he has been connected with the Interborough Rapid Transit Company of New York and the Board of Transportation of New York.

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A Great Progressive Step

Civil Engineering, it is intended, will deserve and, I am certain, will have the unqualified general approval of the membership.

With a freer style than was suitable for Proceedings, it will take over from that publication the portion susceptible of a treatment characterized by brevity and vivacity. It will be the medium of communication with the membership on Society activities: technical, professional, and administrative. It will deal with those interests of the civil engineer that become vibrant as a consequence of the new Functional Expansion Program.

Such a transfer to a publication with a more facile style, with attractive type, with non-transparent paper, and with clearer illustrations, will offer marked advantages. Few members have realized the difficulties which the Society has overcome in producing its Proceedings in the quality and quantity of content which it has been its effort to maintain. Proceedings has constituted a contribution to the highest of technical literature amounting to 1,300,000 words a year, contained in a publication of which approximately 15,000 copies have been distributed free to members, to universities, to libraries all over the world, and in exchange with other societies. It will be continued as the Society's fundamental technical publication, meriting and receiving study and analysis.

With the recent adoption of the Functional Expansion Program, the Society accepted the obligations incident to the improvement of the profession along lines other than technical. The plan devised sets up administrative units whose influence, as time goes on, will be felt far and wide. For the furtherance of that program, if for no other reason, the new publication would be almost an essential.

Civil Engineering will carry advertising matter. These advertising pages should be as interesting and informative as those of the text.

Civil Engineering is to be the work of its contributors, primarily members of the Society, and as such will be just what the membership makes of it. Details, here or there, it cannot be expected, will be entirely satisfactory to each of the Society's 14,000 and more members, but in its conception and general endeavor it certainly must appeal.

I bespeak for Civil Engineering your loyal support, your constructive criticism, your contributions to its pages. I hail Civil Engineering as a great progressive step which has been taken by the American Society of Civil Engineers.

J. F. Coleman

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CIVIL
ENGINEERING

Volume 1 October 1930 Number 1

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Hoover Dam

The Boulder Canyon Project; A Colossal Enterprise

By Elwood Mead
Member American Society of Civil Engineers
Commissioner of Reclamation, Washington, D.C.

A CONCRETE dam over 700 ft. high; a reservoir eight times larger than the Assuan; hydro-electric machinery to develop a million and a quarter horse-power; an All-American Canal, to irrigate nearly a million acres, with an excavation a fourth that of the Panama Canal; a total estimated cost of a hundred and sixty-five millions—such a project is a challenge to the imagination. Dr. Mead in his characteristic way here records the latest developments in the gigantic governmental undertaking which has now received the approval of two presidential administrations.

Boulder Canyon Project on the Colorado River, a flood-control, water-supply, and power development estimated to cost $165,000,000, is unquestionably the greatest engineering enterprise of its kind being undertaken anywhere in the world today. Although the Colorado River is least in volume of discharge of the major streams of the United States, it is of paramount importance in the development of the Nation's resources. Gathering its waters largely from melting snows in the high altitudes of the central Rocky Mountain region, the stream descends rapidly through the southwestern desert region to the Gulf of California in Old Mexico.

PRESIDENTIAL APPROVAL GIVEN

Official approval of the Boulder Canyon Project Act (45 Stat., 1057) was given by President Coolidge on December 21, 1928. This marked the end of an eight-year legislative struggle, and authorized, subject to future appropriations, the construction of a reservoir of not less than 20,000,000 acre-ft. capacity on the Colorado River, the dam to be located at either Black Canyon or Boulder Canyon. The purposes of the act, in order of their importance, are: (1) to control floods and regulate the flow of the Colorado River; (2) to store water and deliver it for reclamation of public lands and other beneficial uses within the United States; and (3) to generate electrical energy as a means of making the project self-supporting. The act also authorized the construction of the All-American Canal to divert water from the Colorado River at Laguna Dam, or other suitable point, and to deliver it to the Imperial and Coachella valleys, in California, the cost thereof to be returned to the Government as provided in the Reclamation Law.

After further consideration of the requirements for flood control, irrigation, and power output, it was decided to provide a reservoir capacity of 30,500,000 acre-ft. with the top of the dam at elevation 1,232 and the maximum water surface at elevation 1,229, a rise from present low water of 582 ft. An initial appropriation of $10,660,000 for the project was made by Congress in the last session and approved by President Hoover on July 3, 1930.

Adequate flood control in the country below was the consideration which fixed the height of Hoover Dam. The higher the dam and the larger the reservoir, the more perfect the regulation. At the height fixed, the lake above the dam will be more than 100 miles long and will hold 30,500,000 acre-ft., or approximately two years' flow of the river. This huge basin, ten times the size of any existing irrigation reservoir in the country, has been given this capacity in order to regulate floods of a magnitude of 300,000 cu. ft. per sec., which is believed to have been the peak flow at Boulder Canyon. The rate of discharge during this flood, which occurred for a brief period in 1884, is believed to have been the maximum over a period of 500 years.

PROJECT BENEFITS SOUTHWESTERN REGIONS

Of the total reservoir capacity, 9,500,000 acre-ft. will be devoted to flood control and will reduce such a flood as that of 1884 to a maximum outflow of 75,000 sec. ft. The largest flood since 1900 would be held to 48,000 sec. ft. at the dam, a discharge which can be safely handled. Gate control throughout the flood storage range will permit further reduction, when temporarily needed, to effect necessary repairs along the river. Such control of the river will eliminate a large part of the present maintenance expenditures for flood control, which average more than $500,000 annually for all agencies engaged in the work.

Diminishing flow in the lower Colorado River, resulting from upstream irrigation and additional diversions to other stream basins, has produced irrigation shortages of increasing intensity and frequency in the lower river basin. This condition has led lower river irrigators seriously to consider taking legal steps to curtail upstream developments. The growth in population of southern

California will soon overtax local water resources so that diversions from the Colorado River will be needed to supply additional water. The storage capacity provided will meet seasonal and hold-over requirements for fully 50 years, assuring unhampered growth within the upper and lower basins.

The construction of the All-American Canal, to carry water to Imperial Valley entirely through United States territory, will remove the uncertainties of maintaining important protective works in a foreign country. Moreover, the higher level of this canal will permit doubling the Imperial Valley irrigated area and the production of considerable power where waters are returned to the stream for Mexican use.

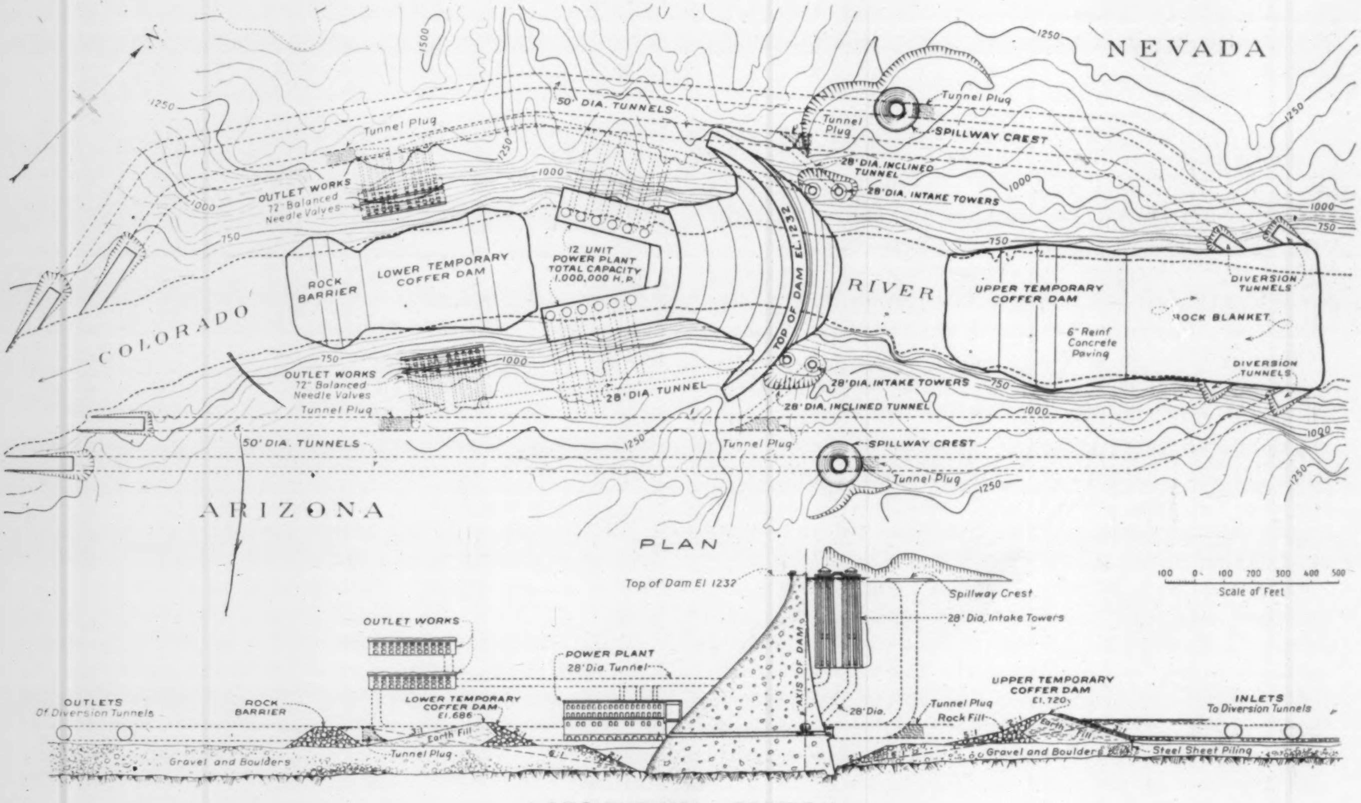
Silt control will not be the least of the benefits obtained. The Colorado River now brings to the delta an annual silt load, variously estimated at from 80,000 to 250,000 acre-ft. The small part of this silt load, now entering the Imperial and other irrigation systems, necessitates an annual expense of fully one-half million dollars for its removal. Were Hoover Reservoir required, for an indefinite period, to intercept all the silt now being transported, the 21,000,000 acre-ft. of capacity available for irrigation, powder production, and silt control would be seriously impaired. With the inevitable construction in the not-distant future of upstream dams and reservoirs, it is expected that the loss in capacity for the first 50 years after completion of Hoover Reservoir will be but 3,000,000 acre-ft. and that this decrease in capacity will be fully offset by the lessened capacity needed for flood control.

The initial power output is estimated at 663,000 hp., declining to 594,000 hp. in 50 years on account of upstream depletion by irrigation. Large amounts of secondary power may be produced in periods of high run-off. The primary market for power is the territory in the vicinity of Los Angeles where it can be delivered at prices less than the cost of local hydro-electric power, and practically equal to the cost of steam power production with present low fuel prices.

OPERATING THE RESERVOIR

The average annual discharge of the Colorado River at Boulder Canyon is now 15,700,000 acre-ft., with an estimated decrease to 11,895,000 acre-ft. in 50 years after the completion of the dam. The discharge during individual years will vary from one-fourth of the mean to nearly three times the mean. Operation for power and for control of floods will meet maximum irrigation demands for a long time. Periods of subnormal run-off of long duration will necessitate conservation of retainable water at all times. Run-off will be forecasted and storage capacity retained for flood control only so far as observed conditions warrant. The present data indicate that, for forecasting purposes, cumulative precipitation records beginning with October are more reliable than snow-cover records. With these data available, operations will be directed to prevent complete exhaustion of flood control capacity in years of moderate reservoir discharges and yet to retain as much water as possible for future needs.

Output of the indicated firm power will be maintained at all times except when storage falls below 15,000,000 acre-ft., when the draft of water will initially be limited to a maximum of 15,000 sec. ft., this amount gradually decreasing with upstream depletion. A dependable


N.
NEVADA
ARIZONA
COLORADO
RIVER
1500
1250
1000
750
Tunnel Plug
50' DIA. TUNNELS
OUTLET WORKS
72" Balanced Needle Valves
ROCK BARRIER
LOWER TEMPORARY COFFER DAM
12 UNIT POWER PLANT TOTAL CAPACITY 1,000,000 H.P.
TOP OF DAM EL. 1232
28' DIA. TUNNEL
Tunnel Plug
SPILLWAY CREST
28' DIA. INCLINED TUNNEL
28' DIA. INTAKE TOWERS
UPPER TEMPORARY COFFER DAM
6" Reinf Concrete Paving
ROCK BLANKET
DIVERSION TUNNELS
Top of Dam El 1232
Spillway Crest
28' Dia. Intake Towers
OUTLET WORKS
POWER PLANT
28' Dia. Tunnel
OUTLETS Of Diversion Tunnels
ROCK BARRIER
LOWER TEMPORARY COFFER DAM El. 686
Earth Fill
Tunnel Plug
Gravel and Boulders
AXIS OF DAM
28' Dia.
Tunnel Plug
Rock Fill
UPPER TEMPORARY COFFER DAM El. 720
Earth Fill
Gravel and Boulders
Steel Sheet Piling
INLETS To Diversion Tunnels
100 0 100 200 300 400 500
Scale of Feet

PLAN

LONGITUDINAL SECTION

power output of large proportions and an adequate irrigation supply are assured under the most severe conditions of protracted low run-off.

EXTRAORDINARY PROBLEMS MET IN DESIGN

Stress problems of unusual magnitude as well as many comprehensive studies of a research nature must be considered in the technical design of Hoover Dam. In designing a dam more than 700 ft. in height, stress factors become very important, which in the design of dams of nominal size are comparatively insignificant. Possible errors in basic design assumptions must be carefully studied and checked; the physical properties and volumetric changes of so great a mass of concrete must be carefully determined; primary stresses caused by the weight of the materials and the horizontal water pressure must be accurately calculated, as well as secondary stresses due to all possible causes. It is believed that, when all factors affecting stress magnitude and distribution are accurately determined and properly considered, the maximum stresses in this design will not appreciably exceed the limit of 30 tons per sq. ft. specified by the Colorado River Board in their report of November 1928.

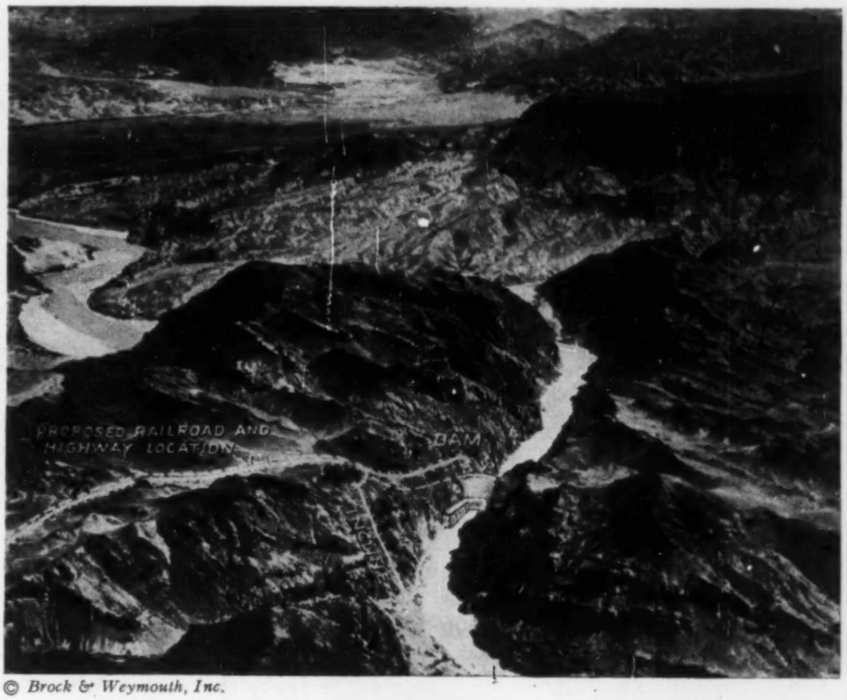
CONTROL OF DISCHARGE

It has been concluded that the river discharge below the dam can be held to about 75,000 sec. ft., with the water surface 3 ft. below the crest of the dam for floods of rare occurrence. In order to provide for any possible contingency it is tentatively proposed to provide spillways which, in case of emergency, can discharge 200,000 sec. ft. without overtopping the dam. The possibility of such a flood is, however, so remote as to be almost negligible. A comprehensive study of spillway problems is in progress, and before the type and location of the spillway are selected, an exhaustive set of model tests will be made.

According to present plans, needle valves, connected to tunnels leading from the reservoir above the dam, will be installed in both canyon walls for the purpose of discharging irrigation water. These valves will discharge directly into the river channel near the location of the lower temporary coffer-dam. Because of the unusual head of water, needle-valve control constitutes the best method of releasing the desired discharges. Part of the needle valves will be connected to the inside diversion tunnels and the remainder to the penstock tunnels, but all valves will receive water through the power-intake towers. As now planned, the only openings through the dam will be the outlets at river level, for passing the low-water flow of the river while the diversion tunnels are being plugged.

RIVER CONTROL DURING CONSTRUCTION

Studies of past floods indicate that a flood of 200,000 sec. ft. will occur once in slightly more than 20 years. On account of the narrowness of the site and the height of the canyon walls, such a volume, or indeed, any reasonable volume, can be provided for only by tunneling. The depth to bed-rock at the upper coffer-dam site is only about 60 ft. at the deepest point. The river bed is filled with silt, fine sand, gravel, and cobbles. Probably there are no boulders of appreciable size above the main dam site. Possible schemes for a diversion dam are therefore limited to types suitable for such foundation conditions. Another important consideration is the fact that the time available for construction of the diversion dam is the period between annual floods, or a maximum of about nine months.



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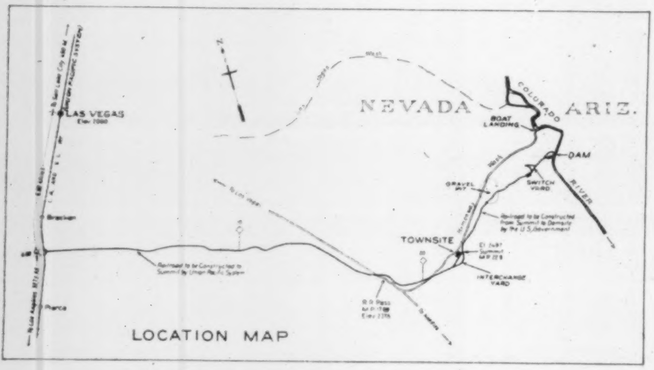
Hoover Dam in the Black Canyon of the Colorado River
Fortification Hill in right background

It is proposed that the Government will assume responsibility for the design and capacity of the diversion works. This responsibility will not be assumed, however, until the tunnels and coffer-dams are completed, in accordance with approved designs. Under this arrangement the contractor will be held responsible for any flood damages occurring during the construction of the diversion works, and the Government will be responsible for any damage and reconstruction costs that may result from a destructive flood occurring after the completion of the diversion works.

UNUSUAL FIELD CONDITIONS SURMOUNTED

A certain amount of preliminary topography has been taken at different times, always under the necessity of covering as large an area as possible with very limited funds. The topography of the canyon walls at the dam abutments and at sites of other structures presented peculiar difficulties on account of the great height of the dam and the steep, rugged, and inaccessible character of the canyon walls. Contracts have been made for the survey of 50 sq. miles by aerial methods and for a survey of the canyon walls for about one-half mile each side of the dam and 730 ft. above the river bed, by ground photographic methods. The aerial surveys cover several possible town site locations, possible sources of concrete aggregate, and areas over which transportation lines to the dam would pass, as well as areas in which the dam and appurtenant works, and the construction plant will be located.

A characteristic of the Colorado River, shared by many similar streams, is the scouring of the bed which takes place during floods. At a rough average, the depth of scour is two to three times the rise of the river at Yuma and about the same as the rise of the river at Topock. At Yuma the discharge often rises with falling gage.



CONSTRUCTION RAILROAD AND HIGHWAY

During the construction period the new town to be built near the dam site will probably have a population of between 4,000 and 5,000. It is planned to make this town a model in every way. Special attention will be given to the construction of houses adapted to extremely hot summers, and cooling systems will possibly be installed in many of the buildings. Possible sites vary as regards accessibility to the dam site; availability of soil for vegetation; cost of water supply and sewage disposal works; scenic values; and climatic conditions. As indicated in the aerial photograph, the ground at the top of the canyon adjacent to the dam site is very rough and consists largely of bare rock, making it undesirable as a town site. The nearest feasible site is three miles away, but the site at Summit, six miles from the dam, where the temperature, soil, and other conditions are the most favorable, seems to be best suited for all purposes, and plans for a town at this location are now being prepared. Every day the contractors' workmen will be transported six miles by railroad to the canyon brink and be lowered on the funicular hoist to their tasks.

It is necessary to construct 30 miles of railroad for the transportation of materials and equipment and to provide access to the dam site. The location for the proposed construction railroad leaves the main line of the Union Pacific System about seven miles southwest of Las Vegas, Nev., and extends 30 miles in a generally eastern direction terminating at the north, or right, bank of the Colorado River. The railroad, for the first 23 miles, traverses open desert country, ascending by easy grades to Summit, where main line operation will end and where the interchange yard will be located. From this point, the line descends for a distance of approximately 7 miles across very rough and mountainous terrain on comparatively steep grades, as high as 5 per cent, to the top of the canyon at the dam site. The Union Pacific System has already commenced to build 22.71 miles of railroad and will operate it under a definite rate agreement with the Government. The Bureau of Reclamation will contract for the construction of the remaining 7 miles from Summit to the dam site, which will be operated and maintained by the contractor on the dam.

Plans are also in process of preparation for the construction of a permanent, inclined or funicular railroad, approximately 1,220 ft. in length, to extend from the top of the canyon on the Nevada side to the proposed power plant site at the river level, 735 ft. below. The cable incline descending the side of the canyon on a 70 per cent slope will not only provide for the transportation of men and equipment to the bottom of the canyon during the construction period but will also be a permanent feature for the maintenance of the power plant. Additional transportation facilities, consisting of railroad or aerial tramways to be constructed by the contractor on the dam, will probably be necessary for the removal of foundation and tunnel excavation and the transportation of concrete aggregates.

A location survey for a highway to be constructed from the town site to the dam has been completed, and a contract for construction will be let at an early date. The highway leading to the top of the completed dam will be constructed according to Federal standards, and may form a part of a national road, crossing the Colorado River over the Hoover Dam, connecting Las Vegas on the Arrowhead Trail with Kingman, Ariz., and affording access to this rugged and scenic region for vacationists and tourists.

POWER DEVELOPMENT

The power plant will be located half on the Arizona side, and half on the Nevada side of the river, immediately downstream from the toe of the dam. The capacity to be installed will depend upon the requirements of the purchasers of the power, but it is expected that machinery to produce about 1,200,000 hp. will be installed. The capacity of the individual units will probably be about 100,000 hp.

There will be four pressure tunnels approximately 50 ft. in diameter, two on either side of the river, each of which will supply water to a group of turbines in the power plant. These pressure tunnels will be provided with trash racks and shut-off gates at the upper end so that any one of the tunnels can be unwatered for inspection or repairs by closing down 25 per cent of the power plant, without interfering in any way with the operation of the rest of the power plant.

The maximum head under which the turbines will operate will be 582 ft., the minimum head will be 422 ft., and the average head 520 ft. All carloads of machinery and equipment to be installed in the power plant will be lowered from the siding on the rim of the canyon into the power house on the funicular railroad, and will be unloaded and handled there by means of the power-house cranes. All rehandling of heavy pieces of equipment at the rim of the canyon will thereby be eliminated. The step-up transformers will be located as close to the generators as the arrangement of the power plant will permit in order to minimize the length of the conductors connecting the generators and transformers. The high voltage switching equipment will all be located in a switch garden on the plateau above the canyon.

The power plant will be operated and maintained by the City of Los Angeles and the Southern California Edison Company, under the general supervision of a director appointed by the Secretary of the Interior. The City of Los Angeles will serve as a generating agent for itself, and for the States of Arizona and Nevada, the Metropolitan Water District, and the smaller municipalities; the Southern California Edison Company will serve as generating agent for itself and the other power companies.

FINANCIAL EXPECTATIONS

The Boulder Canyon Project Act requires that before the construction of the dam and power plant can be undertaken, the Secretary of the Interior shall make provision for revenues by a contract that is adequate, in his judgment, to insure payment of all the expenses of operation and maintenance of the dam and power plant incurred by the United States. The contract shall also make provision for the repayment, within 50 years from the date of completion, of all amounts advanced to the Colorado River Dam Fund for the construction of the dam and power plant, together with interest thereon at the rate of 4 per cent per annum. In accordance with this requirement, three contracts have been entered into for disposal of electrical energy and delivery of water. These contracts provide for the allocation of firm energy as follows:

District	Per Cent
State of Arizona	18
State of Nevada	18
Metropolitan Water District	36
Smaller municipalities	6
City of Los Angeles	13
Southern California Edison Co., Ltd.	9
Total	100

Contracts have not yet been entered into with Arizona and Nevada and the smaller municipalities. However, the City of Los Angeles is obligated to take and pay for one-half of any energy allocated to, but not used by, the states and all of the energy allocated to, but not used by, the smaller municipalities; and the Southern California Edison Company is obligated to take and pay for one-half of any energy allocated to, but not used by, the states. Therefore, the contracts with the city, company, and district provide for the disposal of all the firm energy in case the states or the smaller municipalities do not take or pay for the energy allocated to them.

At the time of completion of the Hoover Dam there will be 4,330,000,000 kw-hr. of firm energy available per year, which will decrease uniformly at the rate of not more than 8,760,000 kw-hr. per year owing to increase in consumptive use of water in the upper basin. The rate for use of falling water for generation of firm energy is 1.63 mills per kw-hr. and for secondary energy, 0.5 mill per kw-hr.

There is no obligation on the part of the contractors to take secondary energy. However, the cost of such energy delivered in Southern California will be less than the fuel cost of an equivalent amount of energy generated by means of steam. Consequently, this will provide an incentive to utilize secondary energy when available. These rates, as required by the act, will be readjusted at the end of 15 years, and every 10 years thereafter, either upward or downward as justified by competitive conditions at competitive centers or points of distribution.

Shifting Sand Near All-American Canal Route

In addition to paying for energy at these rates, the contractors for the power must bear the cost of operating and maintaining the power plant, and pay to the United States, in 10 equal, annual instalments, an amount sufficient to amortize the total cost, including interest charges, of the machinery and equipment installed in the power plant. The contractors must also bear the entire cost of transmitting the energy from Hoover Dam to the points of use.

Assuming that the rates for firm and secondary energy remain unchanged during the repayment period, that the available secondary energy is utilized, and that revenue will be derived from the amounts of water as indicated and based on the estimated cost of the dam and power development, the financial operation of the project would be as shown graphically on the accompanying diagram. Under these assumptions the combined revenue from firm energy, secondary energy, and water will suffice to repay the entire estimated cost of the Boulder Canyon project, including the $25,000,000 allocated to flood control, and including interest charges, in about 34 years.

The cost of the Boulder Canyon project, based on a construction period of seven years, has been estimated as follows:

Dam and reservoir	$70,600,000
1,000,000 hp. development	38,200,000
All-American Canal	38,500,000
Interest during construction	17,700,000
Total	$165,000,000

A total of $165,000,000, subject to subsequent appropriation acts, is provided for in the Boulder Canyon Act.

ALL-AMERICAN CANAL

On account of complications due to the international feature of the present location of the canal providing water for the Imperial irrigation district and for other reasons, it has been found desirable to have a canal built entirely on the California side of the boundary. The Imperial irrigation district, having in cultivation over 400,000 acres in California, is the largest project using Colorado River water below Hoover Dam. Its present canal diverts water from the Colorado about one mile above the international boundary and, following the easiest natural location, crosses the boundary and passes through Mexican territory for more than 50 miles, then recrosses the boundary to reach the Imperial district lands in California. The canal capacity is now about 7,500 sec. ft. supplying some 200,000 acres in Mexico in addition to the California lands.

In the past 20 years, various preliminary surveys have been made for a proposed All-American Canal, and in 1929–1930 a location survey was made by the Bureau of Reclamation. The line on the American side of the boundary, heading at or near Laguna Dam, is located in difficult country, involving heavy work and expensive construction, but the advantages are considered to warrant the extra cost. The following advantages of the All-American route, as compared with the present route through Mexico, are prominent: (1) complete control and avoidance of international negotiations; (2) higher elevation, making it possible to supply the Coachella Valley by gravity flow, and also to reclaim a large additional area of desert land on the east side of Imperial Valley, mainly by gravity; (3) possibilities of power development at drops along the canal; and (4) improved diversion facilities and desilting works.

It is proposed to provide canal capacity for the diversion of 15,000 sec. ft. which will include water supply for the Yuma project, for the Imperial and Coachella Valleys, for the east and west mesas bordering Imperial Valley, and also a surplus for 60,000 kw. of power en route.

The largest canal section proposed is 130 ft. in width on the bottom, with a depth of water of 21.94 ft. The greatest mean velocity to be used in unlined canal is 4.5 ft. per sec. The irrigable area will be increased from 500,000 acres to 900,000 acres. The Coachella branch leaves the main canal at Mile 41 and passes, on the north of Salton Sea, to a point west of Indio, having a length of 115 miles. Four miles of the main canal, and 33 miles of the Coachella branch are to be lined with concrete.

FIGHTING SAND

The present canal was built partly in Mexico because keeping it entirely within the United States involved crossing the low ridge which separates the Colorado River from Imperial Valley. The All-American Canal, as now planned, will follow as closely as possible the international boundary. Ten miles of it will pass through a ridge of shifting sands. The deepest cutting will be between 100 and 120 ft., and, as the sand shifts with the action of the wind, some misgivings have been felt as to the possibility of controlling it. The Bureau of Reclamation, however, has no anxiety. A concrete highway crosses the ridge, and the sand there is kept from shifting by applying oil to it for some distance on either side of the roadway. Similar sand dunes along the Mediterranean coast have been successfully controlled by the planting of suitable shrubs and grasses.

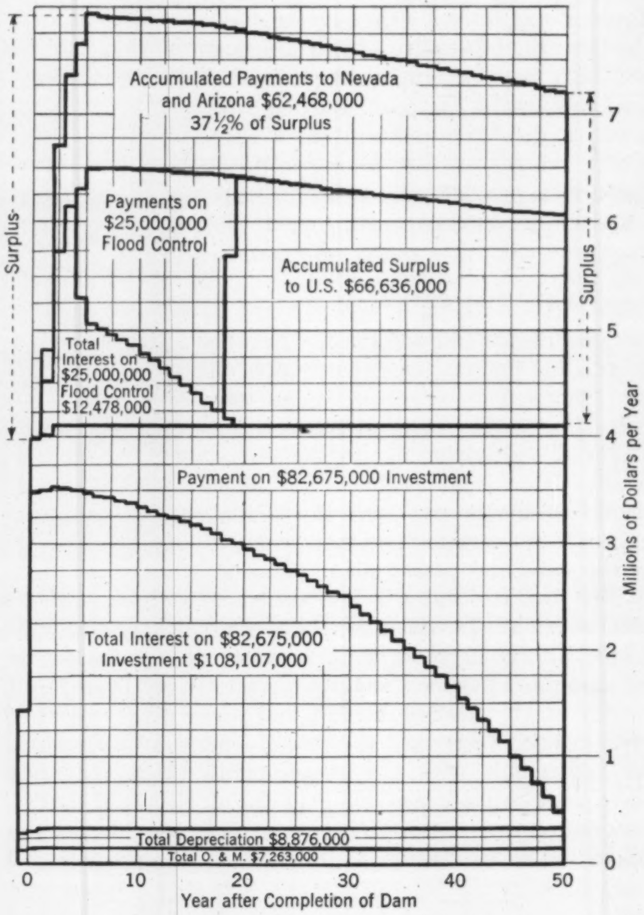


DIAGRAM OF FINANCIAL OPERATION

One or more of the following means will be used to prevent the blow sand from drifting into the canal in the dune country: (1) growing vegetation on the sand in a zone on each side of the canal by means of irrigation from small pipe lines; (2) spraying the sand with crude oil; (3) covering the dune sand with material from the canal excavation, which is too coarse to be blown by the wind; and (4) maintaining a berm 30 ft. wide on each side of the canal at the mesa floor level. With these means in operation, it is expected that the amount of sand blown or drifted into the canal will be small. If an amount of sand sufficient to cause silting enters the canal, it can be removed by suction dredges.

The protection of the All-American Canal from cross drainage and the provision of structures to pass the numerous washes will be items of considerable cost. The plan of crossing is to carry the canal under the flood channels in concrete siphons or culverts. The many wash channels will be concentrated and combined by training levees and diversion channels so as to reduce the number of crossings. On the main canal, 10 such crossings are planned, and 79 on the Coachella branch. There will also be siphon structures to carry the main canal across the Alamo and New Rivers.

The total excavation for the upper location, including the main canal and the Coachella branch, but not including lateral ditches, will be between 60,000,000 and 65,000,000 cu. yd., of which about 4 per cent is rock.

Solving Manhattan's Transportation Problem

Giant Underground Loop to Stabilize Prosperity

By FRANCIS LEE STUART

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CONSULTING ENGINEER, NEW YORK, N.Y.

WHOEVER tackles the urgent question of suburban rail extension into New York City has indeed "caught a Tartar." Its magnitude, its intricacy, its effects on a multitude of existing structures and interests, all add complications enough to deter any but the most stout hearted. Out of many years of study Mr. Stuart has evolved what he feels certain is a rational solution, a separate four-track underground railroad loop, that will improve living and business conditions without favoritism to any section of the entire Metropolitan District. This paper was presented at the meeting of the New York Section, April 16, 1930.

MANHATTAN is the peninsula-shaped central borough of New York City, bordered on both sides by waterways, the East River and the North River. This situation is outlined in Fig. 1. Through the middle of Manhattan runs Central Park, $2^1/_2$ miles long, and $^1/_2$ mile wide, forming distinct east and west sections, which combined may be called "Central Manhattan," and dividing the remainder of the borough into "North" and "South Manhattan," the resulting restrictions preventing the uniform growth of the whole borough.

In character, the eastern and western sections of Manhattan adjacent to Central Park are, and probably will remain, mostly residential. The large section on the north has its own commercial and industrial activities; so have also the four other New York boroughs and adjacent New Jersey communities in the metropolitan area, and all are creating their own local community centers. However, that part of Manhattan south of Central Park, from 59th Street to the Battery, is destined by many circumstances to be the hub of the commercial and social activities which bring prosperity to all parts of that great section known as the Metropolitan District of New York.

Here in South Manhattan are the great hotels, the dense currents of traffic, the shopping district, the headquarters for large and small industries, the great financial institutions, and the main offices of the general business of the country which, in the aggregate, provide the payrolls of the Metropolitan District. It is the destination of the wage earners of families living in that district, and for generations to come it will be the center of all these activities in an intensified sense.

As a consequence, real estate values are high between 59th Street and the Battery, and every effort should be made to stabilize them and the great business interests represented. Inasmuch as the daytime population comes largely from suburban and other sections of the Metropolitan District, there is only one means of stabilization, thereby perpetuating values and prosperity in this and all other sections of the Metropolitan District—and that is to furnish proper suburban transportation facilities for speedy intercommunication between all parts. Such transportation should be so designed that it will automatically aid the city in correcting any street congestion.

Proper suburban transportation involves through-routing within Manhattan, that is, making it unnecessary for passengers to change cars and avoiding stub-end stations with their time- and energy-wasting transfers. The discomfort of riding in subway trains is so great as to render them unsuitable for long suburban rides. Standard size railroad equipment is recommended, with such reasonable comforts as the users are willing to buy.

By "stabilizing prosperity" is meant prosperity in the home and in business. Prosperity in the home assures well-being and the ability not only to earn a growing competency but to earn it with a reasonable amount of the so-called comforts of life. Prosperity in business means, in the sense here intended, the ability to keep the trend of property or of business values moving upward, and this without injuring the city or neighborhood.

DECREASED CONGESTION INCREASES PROSPERITY

This then is not a discussion of the local street distributing system (subway or vehicular), which is so distinctly a function of the city government and the police department. It seems pertinent, however, to consider that a man entering the door of a store, bank, or hotel, is in an immediate position to add to its business activity. On the same basis, if he is on the streets pushing a baby carriage he is occupying the space that four such prospects could use; and if he is in a private automobile he takes up approximately as much room as 34 or more potential buyers.

In time, parking may be inexcusable south of Central Park, and a truck on the street, making deliveries during the daytime, will be considered as clogging the system unnecessarily. Stringent restrictions within this district may bring discomforts but, to avoid congestion, the city may gradually have to accept such disciplinary regulations; otherwise it may even become necessary to give serious thought to the advice so often stressed by competitive cities and ports: "Keep people out of Manhattan and avoid congestion."

It is unthinkable to take the stand that merely through fear of congestion south of Central Park the city should shunt its citizens off to other sections or make it difficult for them to utilize fully this important part of the city. For many years to come, and until the daytime population has been increased several-fold, any harmful congestion can be kept within bounds by proper city ordinances. Every taxpayer has a right to expect to have such facilities furnished and to have his business and real estate values protected.

At present, in order to go from one population center of the Metropolitan District to another, it is necessary to go through Manhattan, usually with at least two transfers and other use of the city distributing systems. People making such trips do not contribute to the business prosperity of Manhattan. One of the first steps to increase prosperity, therefore, is to make all sections of the Metropolitan District accessible to one another without transfer through the streets of Manhattan or other congested centers.

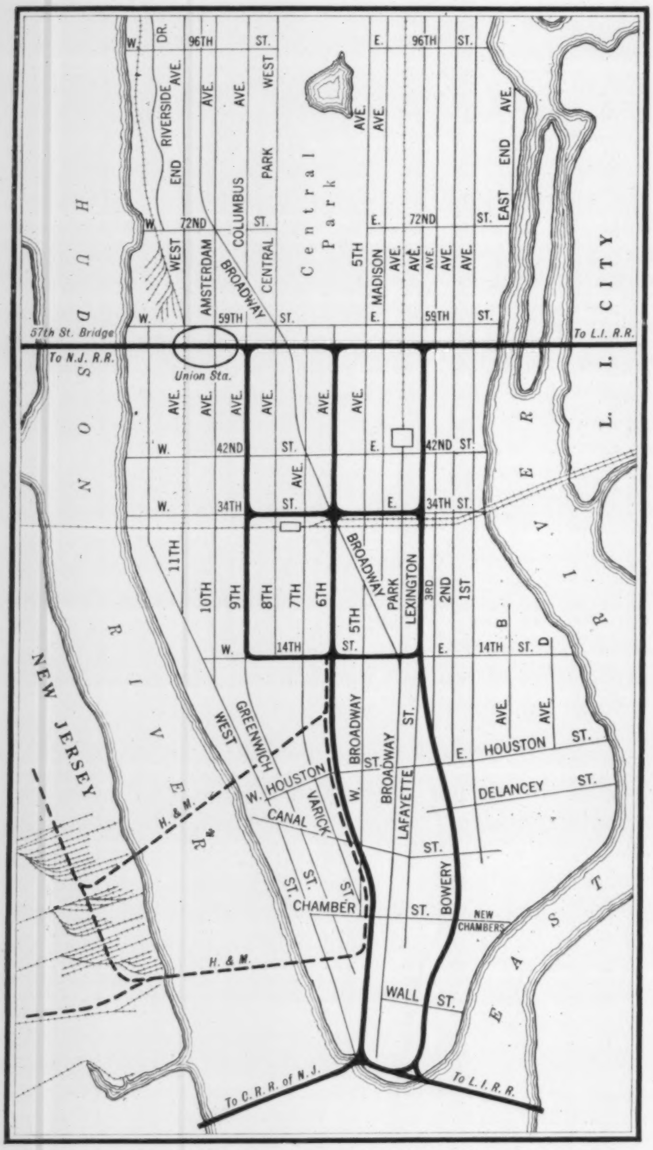
W. 96TH ST.
E. 96TH ST.
RIVERSIDE DR.
WEST END AVE.
AMSTERDAM AVE.
COLUMBUS AVE.
CENTRAL PARK WEST
Central Park
5TH AVE.
MADISON AVE.
PARK AVE.
LEXINGTON AVE.
3RD AVE.
2ND AVE.
1ST AVE.
EAST END AVE.
W. 72ND ST.
E. 72ND ST.
BROADWAY
W. 59TH ST.
E. 59TH ST.
57th St. Bridge
To N.J. R.R.
To L.I. R.R.
Union Sta.
W. 42ND ST.
E. 42ND ST.
W. 34TH ST.
E. 34TH ST.
11TH AVE.
10TH AVE.
9TH AVE.
8TH AVE.
7TH AVE.
6TH AVE.
5TH AVE.
W. 14TH ST.
E. 14TH ST.
AVE. B
AVE. D
HUDSON RIVER
NEW JERSEY
L. I. CITY
EAST RIVER
WEST ST.
GREENWICH ST.
VARICK ST.
W. BROADWAY
BROADWAY
LAFAYETTE ST.
BOWERY
W. HOUSTON ST.
E. HOUSTON ST.
DELANCEY ST.
CANAL ST.
CHAMBER ST.
NEW CHAMBERS
WALL ST.
H. & M.
To C. R. R. of N. J.
To L. I. R. R.

FIG. 1. DIAGRAMMATIC SKETCH OF SOUTH MANHATTAN SHOWING TERMINAL TUNNELS

The long-distance passengers brought to Manhattan are inconsiderable, in point of numbers, when compared with those composing the daily suburban traffic. It is this large daily suburban traffic, drawn from 8,000,000 to 10,000,000 people, that is the chief contributor to South Manhattan's prosperity and, at the same time, the chief cause of the borough's distribution problems.

Under the present system a large part of the daily population pours into the city through stub-end stations such as the Grand Central and Pennsylvania Terminals, and by ferries. About 50 per cent of the entire number reach their destinations by paying an additional fare on one or more of the local distributing systems, such as subways, street cars, busses, and taxicabs. This in itself points the way to the greatest possible improvement in the situation—to deliver the suburban passengers nearer their destination with reasonable speed and comfort, and without depending upon the city's local distributing systems.

BUILD SUBURBAN TERMINAL TUNNELS

South Manhattan is about 5 miles long and 2 miles wide, and almost rectangular in shape, as shown in Fig. 1. The best way to serve this central area from the suburban sections, with the least train mileage and the least congestion on the streets, is by constructing deep north and south suburban terminal tunnels at a depth below the present subways, extending from the Battery to 57th Street. One of these tunnels should be on the East Side and one on the West Side, several blocks apart, each with about five or six stations, delivering most of the passengers within walking distances of their offices and involving the least possible use of the local distributing system.[1]

In order to develop South Manhattan in this manner, the routes should branch off laterally at the southerly end near the Battery and extend by tunnels under the East River for Brooklyn, Jamaica, and Staten Island; while other tunnels should go under the Hudson River leading to Communipaw, Newark, Elizabeth, Bayonne, and Staten Island. In a similar way at the northern end, a crosstown tunnel extending under the East River, would serve Queens and Flushing, and a route by the proposed bridge at 57th Street would lead to Orange, Passaic, and Englewood, N.J. These features are shown diagrammatically in Fig. 2. The present New York Central lines on Riverside Drive and on Park Avenue could connect with these terminal tunnels, and should be augmented whenever needed by new lines leading to Westchester and Connecticut. For operating efficiency and mileage reduction, there should be cross-connections between the east and west terminal tunnels at both ends, and near the center.

If the plan could be executed gradually, as one undertaking, and if the suburban trains from one section of the Metropolitan District to another—say, from Westchester to Jamaica or Passaic, from Englewood to Brooklyn or Newark, or from Flushing to Elizabeth, the Bronx, or Paterson—were routed through these two north and south deep terminal tunnels in Manhattan, then the money spent would be for the benefit of all and would render better service per dollar than any other possible method. The project could be carried out in this way without favoritism to any particular section and for the immediate benefit of all.

These terminal tunnels should be constructed to take standard electrical railroad equipment, and would thus be able to handle the business that will be forced on them. Each should be built with four tracks and with reservoir stations; they should have no track connection whatever with the tracks of the subway systems.

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[1] See general plans of this layout, PROCEEDINGS, Am. Soc. C.E., May 1928, and Discussion, p. 1391.

For passenger purposes only, leases of suburban right of way and the tracks of all the railroads serving the Metropolitan District would be combined, with the new construction, into one large operating company. There would then be unrestricted movement of trains over the suburban rails of all railroads between all parts of the district. All operations would be under the control of the operating company and would function in such a way as not to interfere with or destroy the integrity of trunk-line railway systems bringing freight and passengers from distant points into Manhattan.

At the southern end of Manhattan, entrance would be through tunnels under the river from New Jersey and from Brooklyn, forming at the same time a by-pass from New Jersey to Long Island. At the northern end, the railroads to or from New Jersey by the 57th Street Bridge could be by-passed to or from the Long Island Railroad by tunnel, giving both sides proper connection to these terminal tunnels.

From either side, the present Pennsylvania Station would become a local stop on such a route. Suburban trains of the New York, New Haven and Hartford, and the New York Central R.R. would likewise run into, and deliver, through those deep terminal tunnels. Then the Grand Central Station would also become a local stop. The New York Central route down Riverside Drive would turn east at 57th Street and would go under the Union Railroad Station at the 57th Street Bridge on the west side of Manhattan. There it could connect with the suburban tracks from the 57th Street Bridge, which would bring all New Jersey railroads into the deep terminal tunnels running south.

The proposed bridge at 57th Street would be a very economical tool of transportation in such a plan because of its location and size. A long span of 3,600 ft., with two decks, is contemplated. The lower deck would carry ten railroad tracks, some of them for long-distance passenger trains coming into an elevated union passenger station above the streets, with 28 stub-tracks on two levels. The other tracks would be intended for standard suburban trains to connect with the railroad tracks on Long Island and the terminal tunnels.

A track for a standard-gage railroad across the Hudson would cost about $8,000,000 on a bridge as against $24,000,000 through a tunnel. For the suburban tracks this represents a possible saving of about $100,000,000 in crossing the Hudson River only. On its upper deck this bridge would be wide enough to carry as many as 16 lanes of vehicular traffic, as needed, which would permit several alternate methods of conducting this traffic into the city streets. It would cost $5,000,000 per lane as compared with $14,000,000 per lane through the Holland Tunnel.

In addition, the proposed bridge would make it possible to build a modern union passenger station on the Manhattan side of the Hudson River for travelers from all railroads. This would be a most desirable addition to the city's facilities for serving travelers coming for business and pleasure from all parts of the country, as well as a convenience to suburban passengers. Estimates indicate that it would be self-supporting.

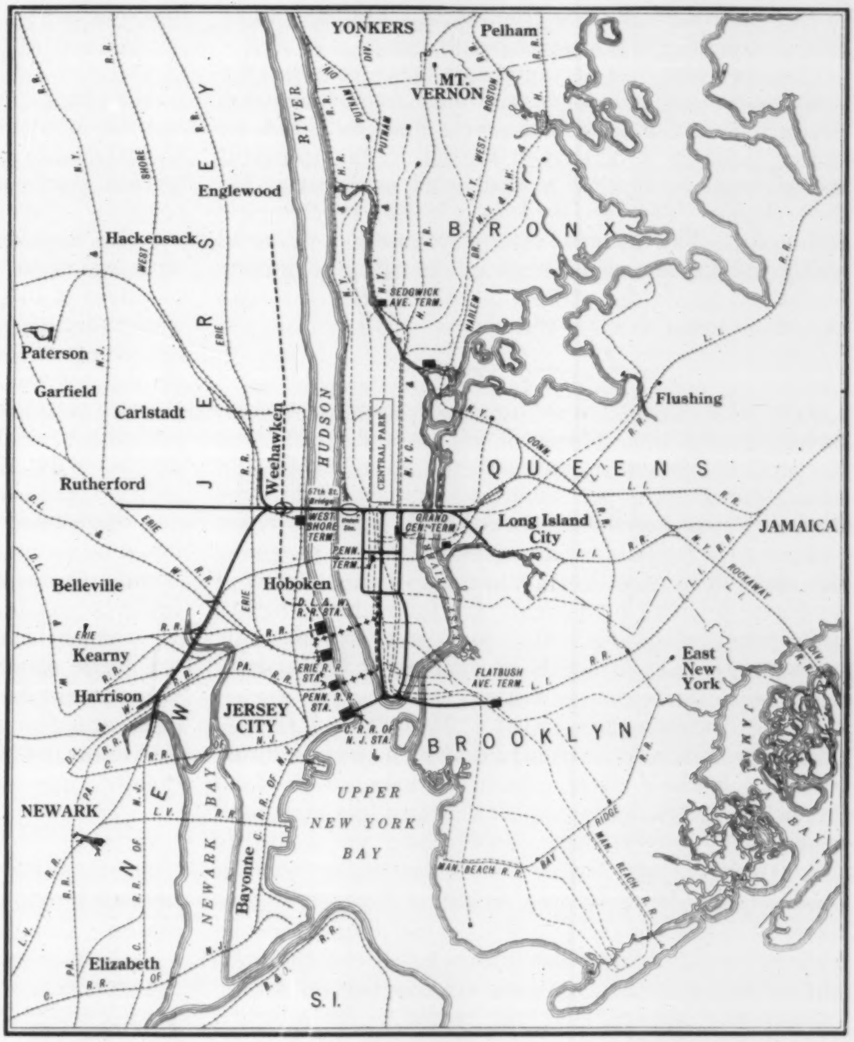
YONKERS
Pelham
MT. VERNON
Englewood
Hackensack
B R O N X
SEDGWICK AVE. TERM.
Paterson
Garfield
Carlstadt
Flushing
Weehawken
HUDSON RIVER
CENTRAL PARK
Q U E E N S
Rutherford
J E R S E Y
57th St. Bridge
WEST SHORE TERM.
GRAND CEN. TERM.
Long Island City
JAMAICA
PENN. TERM.
Belleville
Hoboken
D. L. & W. R. R. STA.
EAST RIVER
Kearny
ERIE R. R. STA.
PENN. R. R. STA.
FLATBUSH AVE. TERM.
East New York
Harrison
JERSEY CITY
C. R. R. OF N. J. STA.
B R O O K L Y N
N E W
NEWARK
UPPER NEW YORK BAY
NEWARK BAY
Bayonne
JAMAICA BAY
Elizabeth
S. I.
ROCKAWAY
MAN. BEACH R. R.
BAY RIDGE
N. Y. C.
PUTNAM
HARLEM
ERIE
WEST SHORE
L. I.
L. V.
D. L. & W. R. R.
PA. R. R.
C. R. R. OF N. J.
B. & O.
N. Y. N. H. & H.
N. Y. WEST. & BOSTON
N. Y. CONN.

Fig. 2. Diagrammatic Sketch of Territory Contiguous to Manhattan and Terminal Tunnels. Proposed New Construction Shown in Solid Lines

DISTRIBUTING OPERATING COSTS

It should be noted that the existing railroads have the collecting and distributing means already available in the suburban territory for intrastate and interstate purposes; but they could not be expected to assume voluntarily further financial obligations in such a reorganization of the present unprofitable commuter business except with the cooperation of all interests concerned and with the assurance that they will have the support of the public rate-making bodies.

As a practical method of inaugurating such a plan, an operating company could be formed by all the railroads. Such a company would lease, for passenger service only, existing rights of way on such suburban railroads as may be needed. It would operate routes through the terminal tunnels on a fare which would be sufficient to pay the operating costs, lease rentals, taxes, interest, amortization, etc., on the entire cost of the system.

Such a suburban transit system, covering the Metropolitan District within a radius of 20 to 50 miles, could be built gradually and would cost approximately from $1,250,000,000 to $1,500,000,000. By the time it could be completed it would probably be carrying 700,000,000 passengers yearly, and might add from 10 to 15 cents to each railroad fare to or from Manhattan, depending on the amount of benefit assessments levied.

There is a possibility of equalizing the rates of fare for similar distances in all directions from South Manhattan. Residential sections are sufficiently numerous and industry sufficiently diversified for all to find pleasant homes conveniently close to their work at a cost within their means. The rate benefits achieved by this plan will be such that the great mass of commuters delivered within walking distance of their offices without transfers can afford, and will gladly pay, the cost of such service and of improved living conditions.

OTHER SAVINGS EFFECTED

This plan of through-routing with terminal tunnels under Manhattan, operated with standard railroad electrical equipment as outlined, will save at least 10 min. per passenger per suburban trip, which is more than any plan heretofore discussed. The construction will cost very much less than any other method providing the same facilities with as little congestion. I know of no better or more permanent way for maintaining the healthy and balanced growth of business or for stabilizing real estate values in South Manhattan and prosperity in the whole Metropolitan District.

In first discussing this sum of $1,250,000,000 it seemed difficult to convince the layman that such an expenditure would be justified.[1] Since then, however, the Holland Tunnel from Manhattan to New Jersey has been built near Canal Street, New York City, at a cost of $54,000,000 for four lanes of vehicular traffic, which is profitable at 50 cents per vehicle. Because of the financial success of this venture, several tunnel schemes without unified plan, amounting to several hundred million dollars in the aggregate, are now being discussed regardless of the fact that they would be for vehicular traffic only. While they are much needed and desirable conveniences for such traffic, they could not begin to give the widespread relief which a circulating and connecting railroad system, such as that described, would afford.

Other plans now under consideration would cost large sums. Some of them may have merit and deserve serious thought. They may fit into the general scheme, which must deal with the suburban transportation problem as a whole if the great business projects in Manhattan, on which solid prosperity depends, are to be stabilized. The problem touches the comfort, the happiness, and the culture of all the inhabitants of New York City and its environs. Individual effort or sectional effort will be ineffective and cannot succeed in creating a desirable working plan.

The important factor to consider is that the going business concerns, the great buildings, and the real estate values between Central Park and the Battery are the physical result of concentration. They supply the impulses and the inspiration behind the growth of the city. If this section is to keep pushing forward the prosperity of the rest of the Metropolitan District, a lesson must be taken from the past. This section must be provided with proper rail transportation tying it up with the entire district and planned to largely relieve, automatically, the subways and street transportation systems, and thus free them for their more necessary local duties.

FINANCING BY BOND ISSUES

As to financing, in view of the certain and permanent cash earnings of the proposed plan of transportation, and the possibility of regulating the rate of fare for such service, there seems to be little difficulty in finding a solution. This may be accomplished without involving the city or other public credit, and without interfering with any of the city's ordinary spheres of action. The securities of this system, supported by the needs of such a vast and growing population, and based on an agreement as to rate of fare required for stable financing, approved by the Interstate Commerce Commission, by the two states, by the city, and all other necessary legal authorities, would be a very desirable offering to investors and could be marketed on unprecedented terms, probably $3^1/_4$ per cent or less.[1]

A single bond issue of a billion and a half, all on parity, based on an essential utility, such as the transportation herein discussed, and a rate for service as outlined, could be so arranged as to have a stabilizing influence. It would be most helpful in lubricating the finances of the entire country; it would be almost as desirable as Government bonds (at times more so); and it would command an unprecedented rate if based on absolutely fair terms, which recognize the fluctuating value of the dollar.

INTERESTING PROBLEMS INVOLVED

So much for the more technical elements which are necessary to a thorough understanding and study of the matter. The more interesting questions are:

1. Is there a need for these improvements?
2. Will they cost too much, that is, can the project pay for itself?
3. Will this plan injure the present business of the subways?

First, are these improvements justified by necessity? For an answer to this question ask the commuters from New Jersey and Long Island who have suffered from the evils of transfers for years; ask the subway "rush-hour" rider, whose two hours of efforts to protect himself are developing an unfortunate impoliteness in the average New Yorker; ask the owner of a city skyscraper, or the owner of a home in the suburbs; ask the owner of vacant property; and finally, read the statistics and traffic trends which have been published by authorities and students of the problem.

All charts of progress are upward, as may be seen by looking back 50 years and considering how population, business, and industry have grown to their present proportions in the Metropolitan District of New York.

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[1] PROCEEDINGS, Am. Soc. C.E., May 1928, Papers and Discussion, p. 1393.

They are still growing, and the city is therefore compelled to face the necessity of solving the problems here discussed. The lack of a definite plan tends to an irregular growth, whereas the plan outlined, if executed, would accelerate the rate of growth of the total population of the Metropolitan District in an orderly way.

Can the project pay its way? Many estimates have been made and public bodies have spent about a million dollars on suburban studies. Here is a simple way of computing the costs. Assume that the present commutation rates pay the railroads for the cost of service. Then enough must be added to the rates to carry the operating cost on the few miles added to the trip and the cost of the new construction. Assuming 700,000,000 riders at 15 cents each, the cost will be $105,000,000 per annum. Assume an operating cost of 42 per cent (as on the Hudson and Manhattan Railroads); then $44,000,000 will be needed for operating expenses, leaving $61,000,000 for dividends. Then there are by-products which will add another $20,000,000 earnings, giving a total of $80,000,000 to pay interest and amortization on $1,250,000,000.

While time has a monetary value, it is difficult to put a defensible value on time before and after office hours. In any event, there will be a saving of 10 min. or more per trip. If 10 min. is worth 10 cents, the saving for time alone is $70,000,000. As to the value thus added to real estate in Manhattan and the entire Metropolitan District, its rate of increase is only within the realm of prophecy and everyone can draw his own conclusions.

Will this plan injure the present business of the subways? It will increase the use of Manhattan and the territory within the area of influence of the subways so that, while losing some long-haul passengers, they will more than make up the loss by an increase in short hauls. It will also provide the city with transportation facilities equal to the capacity of several subways without using the first level below the street for such purposes.

EQUALIZING ACCESSIBILITY TO MANHATTAN

Transportation has to be paid for by fares or taxes. If the population of the entire Metropolitan District be given proper consideration, the improvement most desirable to all is the one that makes Manhattan equally accessible to all sections, rather than to any particular or favored section; and for the same reasons all sections should be equally accessible to one another, without favoritism.

In judging the best project, the determining factor must be the greatest good for the Metropolitan District as a whole per dollar spent. The fact that the plans outlined here can and will be most helpful in bringing about these improvements in living conditions is the main reason for presenting them.

By and large, the City of New York has done wonderfully well in meeting this transportation obligation, the crowded rush hour to the contrary notwithstanding. Doubtless city officials are willing and eager to carry out a plan of improvement if they can be shown that it is the best one for all concerned. These terminal tunnels and their proposed connections are simply extensions of existing railroad facilities. There is no destruction of existing means of transportation, and the construction can proceed without interfering with existing services. It takes time to execute such an undertaking and time presses.

Subway distribution and suburban transit are separate problems and require separate solutions. The Hudson and Manhattan Railroad, the subways and busses, all have their place in the plan, but are purposely not discussed. The city, state, Suburban Engineering Board, and the Port of New York Authority plans are also not discussed. All details have been avoided because they may distract from the main principles and ideas presented and because the selection of routes and similar details should be left to city or other legal agencies.

There is nothing difficult about the project except the inertia of the public; and, after all, the real factor is the public. The public should realize that, within a few years, whether it wants to believe it or not, 50 per cent of all those entering standard railroad passenger coaches on all the railroads of the United States will board them in the Metropolitan District, provided the improvements in the city's transportation system are so designed that they do not block its prosperity.

Broadway at Herald Square

Photo by Courtesy New York Board of Transportation, New York City

This view, looking north from 34th Street, is typical of the street congestion found in New York City. Pennsylvania Station is two blocks to the left of the subway entrance shown in the foreground. Note absence of pedestrian control in crossing streets.

Research Advances Civil Engineering

By Alfred D. Flinn

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As a word, "research" has been much maligned; but not the type of research here treated by Dr. Flinn. In his duties as Director of Engineering Foundation for many years, he has been closer perhaps than any man in America to numerous and varied research problems in civil engineering, many of them of truly monumental character. No civil engineer is better qualified to speak authoritatively on this live topic.

This paper is a condensed version of a lecture delivered before the Civil Engineering Session of the Summer School of Engineering Teachers of the Society for the Promotion of Engineering Education at Yale University, on July 2, 1930.

HOW can all existing knowledge that should be utilized on a given project be quickly put into the hands of the man on the job, so that he can be assured that he is doing his work with the benefit of all the known facts which bear on his problem? This question confronts us with one of the most deplorable of human handicaps, our greatest cause of waste, namely, the inaccessibility of knowledge.

So comprehensive is the practice of civil engineering that engineers of single great enterprises have to apply directly or indirectly a large portion of human knowledge, including not a few subjects which at first mention would seem to the uninformed far afield. Consequently the variety of research affecting civil engineers is very broad. Many civil engineers are not even aware of their vital interest in research in some subjects. Research is constantly supplanting old data, which are found to be incorrect or no longer sufficiently precise. More data of higher precision are needed. Inaccurate data and wrong conceptions of the nature of substances and their performances under various conditions of stress, motion, temperature, and moisture lead to faulty practice eventuating in economic waste, failures, and even disasters.

PROGRESS IN KNOWLEDGE IS ACCELERATING

Precedent and tradition may be helpful guides if their limitations are kept sharply in mind. Assumptions are forced upon us by a variety of circumstances, and will be for an indefinite future. The function of research is to substitute determined knowledge and principles for assumption, tradition, and precedent. No restricting definition of the word research will be attempted, the broadest possible interpretation being considered applicable. It is the obligation of engineers to promote research so that their practice may be safer and more economical and so that they may achieve new and greater services for the public.

Research, in many fields, is producing new materials, methods, machines, processes and tools; new forms or combinations of familiar things; also new attitudes of mind, new desires and necessities among the clients of civil and other engineers. Besides research in the physical, mathematical, and biological sciences, investigations in economics, education, government, law, language, medicine, psychology, and other branches of human interest affect the civil engineer's work directly, as well as including him with other men in their general influence.

Constant progress in knowledge, accelerated in recent years, causes changes of requirements in public works, transportation, structures, and other provinces of civil engineering. Consequently researches in civil engineering are necessitated in greater variety and magnitude than ever before. Special laboratories for research as well as for tests are being provided for some of the great civil engineering enterprises. Engineering structures, too, are being utilized for research more extensively than in days gone by, and civil engineering research is finding its way into industrial laboratories. For example, while visiting the beautiful, finely equipped new laboratory of the Aluminum Company of America at New Kensington, Pa., the author found developing a research on concrete arch dams, in which a model and precise instruments in the laboratory will be utilized for comparison with measurements of deflection, strain, and temperature to be made with precision on the 210-ft. high Calderwood Dam which the Aluminum Company of America is building in Tennessee for power. This project is taking advantage of the extensive experimental investigation of arch dams by Engineering Foundation and the American Society of Civil Engineers.

VALUE OF RESEARCH

Larger and better laboratories are being created also for our engineering colleges. Because this branch of the profession needs research along many lines, and because problems demanding investigation develop more rapidly than solutions are attained, civil engineers should encourage all research contributing in any way to the knowledge which they utilize for their clients or employers, or which affects their services to society.

Classified according to auspices, engineering research may be differentiated as private (conducted by individual persons or companies), governmental, and society. There is a great and growing amount of research in the first class; many millions of dollars are expended annually, and a modest portion goes for research in civil engineering. Federal, state, and municipal governments devote in the aggregate much money to engineering research, probably the larger portion going into the domain of civil engineering. Several engineering societies are conducting effective applied-science researches in a wide variety of subjects. Their funds are still meager and the number, magnitude and speed of their projects are thereby limited.

When the rank and file of engineers awaken to a keener appreciation of the relation of research to their own income, their efforts to obtain adequate funds through their societies will be mightily strengthened and intelligently unified. Casual observation indicates that the great majority of engineers, excepting chemical and electrical engineers, are not yet awake to their individual, personal concern in both pure and applied science research. It is not easy to stir the older engineers to more than inert interest. Teachers of physics, chemistry, engineering, and mathematics should be able to arouse greater interest in research in their students now and in the days to come.

ORGANIZATION OF INVESTIGATIONS

Society research is, in the main, appropriately devoted to problems of general interest to engineers and industries, without prospects of immediate commercial profits controllable by individuals. Solutions of problems of the broadest public concern, requiring large sums of money or special authority, are the tasks of governmental organizations. Societies are concerned mostly with getting new or better basic data for engineering practice and with problems not likely to be investigated by governmental or private agencies.

Society research is necessarily cooperative in one way or another. Its organization is commonly of the committee type; but for many projects, the committee, to be effective and achieve results within reasonable time, must be provided with helpers whose bread-and-butter job is the committee's work. Committee members usually give their services, and sometimes also expenses reaching large totals, as contributions to the welfare of their profession and the public. However, their primary obligations are elsewhere, and rarely can they divert time and energy sufficient for much experimental work. Their activities ordinarily are restricted to organizing, directing, and reviewing, and constitute contributions of a value that cannot be measured in money. No society research should be undertaken until the purpose has been defined, a tentative program formulated, interest ascertained, and able committee members together with competent researchers found.

Each committee should have as few members as practicable, and they should be chosen for special knowledge of the subject, for liaison, and for capacity to cooperate. Each committee should be required to submit a budget and a program, which may be revised as occasion demands. A committee should not incur obligations beyond the funds assured for its work. It should periodically account for the resources provided and give proof of faithfulness by progress reports. Results should be expected within a reasonable time.

PRELIMINARY STEPS TO RESEARCH

Researchers are much needed—not young men crammed with facts in one or another branch of engineering, but men who have been given intelligent mastery of the fundamental sciences, whose powers to observe, analyze, and interpret have been developed, who are soundly interested in the search for new knowledge, and who can get results without being coached on every detailed step toward the goal.

Opportunities for real researchers have for years been reported to exceed the number of competent candidates available. Such men will always be in demand or have opportunities for unselfish service, until, if ever, another "dark age" is brought on by man's stupidity. Students with right aptitudes should be encouraged to choose research as a career and be informed of its satisfactions as well as its possible financial rewards. They should be told about the numerous research establishments, governmental, industrial, and institutional, and be encouraged to visit some of them.

RECORDING RESULTS ELIMINATES WASTE

Civil engineers, equally with their professional brethren in the younger specialties—mechanical, chemical, electrical, metallurgical, automotive, and aeronautical—should be conducting research to increase the store of knowledge needed not alone for present, but also for future engineering enterprises. If anyone doubts the need for civil engineering research, and for a great deal of it, let him hasten to inform others how else the differences of practice under substantially identical conditions, with the attendant waste, can be brought to an end. Apart from differences for which valid reasons can be given, there are large discrepancies which should disappear if indisputable knowledge were available.

A few examples of such differences in practice are: under practically identical conditions, some engineers paint steel to be embedded in concrete, but others do not; some concrete dams are much thicker than others; some railroads use one shape of rail and others another; and there are scores of variants among engineers' specifications for steels, cements, and other materials, and for culverts, spillways, levees, retaining walls, and foundations, to mention only a few. Would there not be real advantages in substituting research for discussions based on assumptions or on opinions which at best are often worse than useless, because misleading? Even deductions from experience, as frequently reported, may be seriously in error. Lessons can be safely drawn from experience only when principles and procedures used by competent researchers are employed.

SUBJECTS FOR RESEARCH VARIED

Accepting the term "civil engineering," with its present-day meaning, as one of the classifications made for convenience, let us say that it is concerned with substances and forces in the gross. The purposes of civil engineering research, then, are to get basic data for use in creating, maintaining, operating, or valuing structures (defining "structures" in a comprehensive way); and also to solve specific problems of engineering, industry, and public works, rather than to discover fundamental truths in the field of pure science. In every subdivision of civil engineering there is need for more or better knowledge, that is to say, for research and its fruits. The type of problem that comes within our category can be indicated by listing some of the subjects with which the American Society of Civil Engineers and Engineering Foundation have been concerned in recent years.

HYDRAULICS
- Measurement of flowing water
- Hydraulics of pipes and conduits
- River hydraulics
- Irrigation hydraulics
- Rainfall and streamflow

STRUCTURES
- Arch dams and dams in general
- Steel columns
- Bridge design and construction
- Welding
- Concrete arches
- Earth and foundations
- Earthquake stresses
- Retaining walls

MATERIALS
- Cements
- Concrete (*flow of concrete*)
- High strength metals
- Painting metals
- Wood preservation
- Corrosion protection

MISCELLANEOUS
- City planning
- Valuation of railroad, utility, and industrial properties
- Aerial surveying and mapping
- Testing small models

TRANSPORTATION
- Highways and traffic
- Stresses in railroad track

Progress in the technic of research, improvements in apparatus, and advances in physics, chemistry, mathematics, and other sciences are bringing within the range of experimental research many problems that have been deemed subjects only for crude observations in experience, shrewd judgment, and intuition. In mining, the determination of sizes of "rooms" from which ore is removed and the dimensions and spacing of the pillars or other supports for the rock above, furnishes perhaps as good an example of this sort of problem as can be found. Nevertheless, the resourcefulness acquired by years of research experience in physics and engineering has recently produced a simple apparatus and methods for the solution of this problem, by which it now appears that great numbers of determinations can be made on specimens of manageable size and shape at low cost and within brief time. This method also has possibilities for numerous civil engineering problems.

Other problems of civil engineering may also be brought into the laboratory. The notable instance of arch dams has already been mentioned. Hydraulic laboratories in engineering colleges, some of them well equipped, and the National Hydraulic Laboratory, to be built at the Bureau of Standards in Washington, offer facilities for research on many problems yet unsolved. Observations upon structures built for service may be made parts of intelligently coordinated research programs and thus greatly enhanced in value. When more civil engineers get the research habit of mind, they will be able to foresee opportunities for practical research, and many valuable additions to our stock of knowledge will be made at moderate cost.

LIBRARIES INDISPENSABLE TO RESEARCHERS

Finally, it must be remembered that all research projects should begin in the library. Persons or groups contemplating researches ought first to inform themselves of the "present state of the art," so as to get the full benefit of existing knowledge and avoid wasteful duplication. The search for existing literature on the subject chosen and for unpublished information should not be restricted. Many instances have occurred of the finding of useful data or helpful suggestions in fields at first thought wholly unrelated to the subject. If local libraries are insufficient, larger and centrally located libraries may be able to help. The Engineering Societies Library, in New York, and the John Crerar Library, and the library of the Western Society of Engineers, both in Chicago, are examples. The Engineering Societies Library, the joint library of the national societies of civil, mining and metallurgical, mechanical, and electrical engineers, serves engineers and industries in all parts of the world. Researchers can help one another, and engineers and industries in general, by making reports of their researches available through libraries and other channels as soon as seems advisable. Premature publication, however, is to be avoided. Thus the library should be remembered at the end, as well as at the beginning, of a research. Universities and their laboratories are esteemed by the four founder societies and by Engineering Foundation as favorable places for the kinds of research in which the societies are interested. Utilization of college laboratories for society research is especially advantageous.

A number of universities and engineering colleges have established procedures and policies for dealing with civil engineering and other research projects brought to them from the outside, particularly those originating within their own states or among their own alumni. If a university or an engineering college is not prepared to undertake outside research projects, or if a proposal is made that requires cooperation or expenditures beyond the scope of the university or college approached, then outside aid should be sought.

Pure science projects should be discussed with the National Research Council, in Washington, D.C. For applied science or engineering researches, help may be sought from Engineering Foundation through one of its founder societies, from the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. An application to Engineering Foundation should outline the project, the results expected, and the state of the art as known to the applicant; it should state resources in facilities, funds, and men available to the applicant, with probable sources of additional help, and give an estimate of time and cost.

ENGINEERS MUST BE LEADERS

Researches and investigations—planned endeavors to put knowledge in the place of assumption, tradition, and ignorance—are steadily being undertaken in more subjects, on larger scales, and with more effective facilities and methods, in all departments of human affairs in enlightened nations. Benefits of research and the spirit of research must be spread among all the peoples of the earth, and engineers must be among the leaders in advancing man's understanding and mastery of himself and his environment, with the innumerable benefits to be attained. At one end of the scale the proportion of the population that can contribute only brutish muscular effort should become smaller and smaller, while, at the other end, the numbers who can aid in the increase of understanding must increase. A wiser distribution of the resources of mankind must be achieved so that those men who can contribute to upward progress—the real creators of well-being—may be adequately supplied with the means for their service. This is the why of civil engineering research.

Ingenuity of the Ancient Chinese

Engineering Works, Twenty-four Centuries Old, in Use Today

By E. W. Lane
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Research Engineer, U. S. Bureau of Reclamation, Denver, Colo.

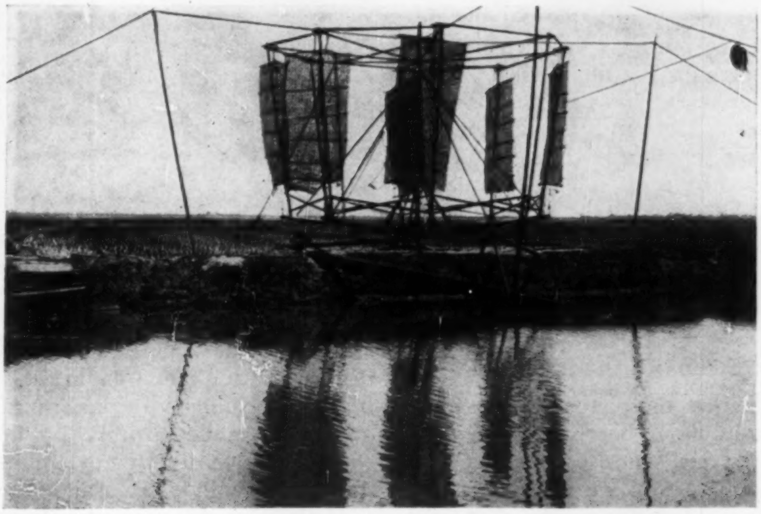
PARADOXICALLY, Chinese ingenuity has given modern civilization many basic inventions upon which its structure has been built, yet Chinese engineering methods offer little of practical value to the builder of today. The reason for this apparent paradox is given by the author in a convincing and interesting manner, which creates a better and more sympathetic appreciation of Chinese engineers. Mr. Lane, who is now research engineer for the U. S. Bureau of Reclamation, was employed for many years in China by the Kiangsu Grand Canal Improvement Board in studies and improvements of a portion of the Grand Canal.

CHINA'S civilization is the oldest in existence, being approached in age only by that of India. By the side of it the three centuries of the present American civilization and the mere century and a half of our national existence are almost insignificant. This is strikingly brought out in the diagram (Fig. 1), which shows at the top the relative periods of Chinese history compared with some of the great events of history. An almost insignificant block represents the period of national existence of the United States.

It is evident that some of the greatest Chinese works, the Great Wall and the Min River irrigation projects, were constructed over twenty centuries ago, a period equal to fourteen times the age of our nation, and that the construction of the Grand Canal extended over at least eighteen centuries, or twelve times our nation's age. This does not mean, of course, that the canal was under construction continuously during this period, but that this time elapsed between the first historical reference to its existence and its completion.

ENGINEERING EVOLVED EARLY

Engineering has always held an important place in Chinese life. One of the national heroes is the Great Yu, who regulated all the rivers and fixed them in their courses. This man lived over forty centuries ago and, while a great deal that is told of him must be purely legendary, there is at least enough basis in fact to warrant the belief that even in that remote time engineering was highly developed.



A Windmill Driven Pump

Early stages of development were completed so long ago that it is impossible to determine whether progress was slow or rapid; but within historic times the advance has been very slow. The stage reached by the Chinese before the introduction of Western ideas is closely comparable to our condition before the invention of the steam engine, although in some instances they attained a higher development. There is little in their early work that can be classed as mechanical, electrical, chemical, or sanitary engineering. However, in the invention of certain kinds of pumps, the magnetic compass, and gunpowder, and in the use of alum to coagulate muddy water, they were far ahead of us. If, from our advanced stage, we are tempted to look down on some of their engineering methods as primitive and crude, we will arrive at a much fairer judgment by considering the many centuries in which they could, with even more justification, look down on our ancestors for their almost total lack of engineering development.

INGENUITY THE RULE IN CHINA

In China, the growth of engineering has been greatly influenced by conditions peculiar to that country. The low, flat, densely populated plain along the sea, subject to frequent floods, led to the development of extensive flood protection works. The ease with which canals could be built and the need of them for the irrigation and drainage of rice fields led to the development of what is probably the most extensive system of canals in the world. Out of the canal system grew a high development of bridge building. The same conditions affected mechanical engineering, and the greatest progress in this field has been along the line of pumps and water wheels.

The engineering development of the Chinese has been retarded, as ours once was, by the lack of motive power. They have developed both undershot and overshot water wheels as well as the noria, or water wheel with vessels on its circumference for raising water. The most thickly settled parts of China, however, are the plains, where the chances of developing water power are small.

The Chinese have made extensive use of wind power by means of windmills. In the mill shown in the photograph the entire structure revolves about the center shaft, which is supported by ropes and poles. The vanes, made of woven reeds, are pivoted slightly off-center so that they advance edgewise on the side moving toward the wind and turn broadside to it on the other. The mechanism is connected to a low-lift pump for raising water to irrigate the rice fields.

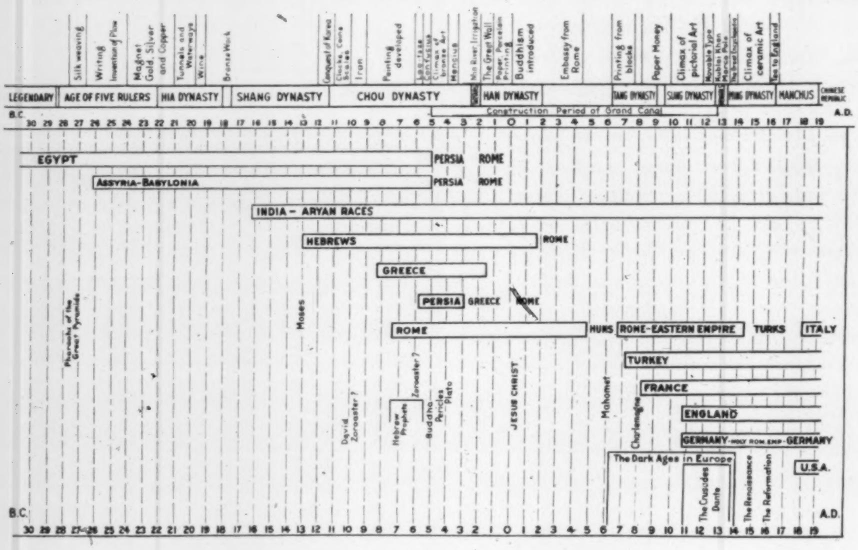


FIG. 1. CHART OF WORLD HISTORY SHOWING CHINA'S SHARE

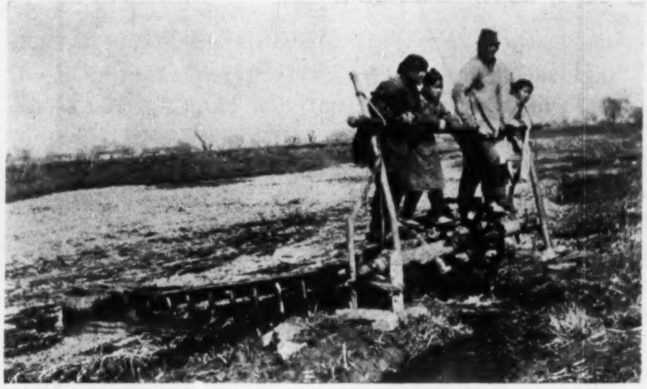
In this type of pump, also shown in detail, the Chinese have reached their highest development in the field of mechanical engineering. It consists, as will be seen, of a trough through which moves an endless chain carrying paddles that extend across the trough, with a close fit on the side and ends. The trough is set at an angle, rarely more than 30 deg. with the horizontal. The chain is driven by a sprocket wheel at the end of the trough and moves the paddles up the trough, pushing the water ahead of them. Note the ingenious use of a floating tub at the intake end to maintain proper submergence at varying water levels, and the aligning device on the main shaft. The pump is built entirely of wood except for the bearings on the main shaft. It is doubtful if our boasted engineering has produced a more efficient pump for low heads. Certain it is that we have nothing that is likely to take its place in the near future. Yet this pump was invented by a disciple of Confucius, named Tsi, who probably lived about the same time as the Biblical Abraham. Man and animal power still predominate in China and thousands of these pumps are run by a prime mover of one "water-buffalo power" or several "man power."

FACILITY ALONG MECHANICAL LINES

So far as I have seen, neither the piston nor the more recent centrifugal principle have been used in their pumps. The piston principle is used extensively, however, for pumping air. Many of the tea shops have a double acting piston pump to supply air to the fire for heating the tea. A similar pump is also used in native foundries. The one pictured has approximately a 12-in. bore with a 5-ft. stroke. It is made of wood, and wooden tubes carry the air, under pressure, from each end of the cylinder to the cupola. To pour, the cupola is tilted forward on its supports and the molten iron runs out into a ladle. Dry sand molds are used, some of which appear in the foreground.

None of the castings being made here is large, but cast-iron idols 10 ft. high and other large iron castings are sometimes seen. The ingenuity of Chinese craftsmanship is better shown, however, in small than in large pieces. Most of the food is cooked in cast-iron pans which are often cracked by the heat. The pan mender carries around his cupola, about the size of a quart measure, and melts the iron in a crucible hardly larger than a thimble. He pours a globule of molten iron on a wad of cloth covered with ashes and quickly presses it up into the crack in the pan, at the same time pressing down from above with a similar wad. A perfect rivet is formed, and by putting a series of such rivets from end to end the crack is mended. The Chinese mend broken glass or china in an equally ingenious manner with a number of brass staples set into minute holes bored in the sides of the vessel.

In natural ability along mechanical lines, the Chinese are not lacking. At one time, in an interior city, the lock of my trunk was broken and some of the parts were lost. It was a complicated mechanism, difficult to put together even when all of the pieces were available. In spite of the apparent hopelessness of making repairs, the lock was sent to a local craftsman and came back with the missing springs and levers all made by hand. It is doubtful if many American mechanics could have done as well. The Chinese mechanic has developed wire drawing with a metal die in the same way that it is done in our wire mills. In one interior town, striking clocks are being made entirely by hand. It is doubtful if they were invented by the Chinese but no small degree of mechanical skill is necessary to produce them.



CHINESE IRRIGATION PUMP

If the Chinese are so skillful along mechanical lines, the question naturally arises as to why, with the high state of development reached long ago, more progress has not been made. The cause lies not in the ability of the Chinese, but in their viewpoint. Their lives are very deeply influenced by the teachings of Confucius. For the most part his philosophy is good, and its faults, which perhaps more than anything else are responsible for the immobility of Chinese civilization, consist not in wrong teaching but in an exaggerated emphasis. Respect for parents and ancestors is not a fault; our own civilization would be improved by more of it; but, under the Confucian system, it is exaggerated to such an extent that it has seriously retarded progress. An attempt to do anything in a new or better way becomes a reflection on parents and ancestors for, if the old way was good enough for them, to attempt a better way indicates that one considers himself superior to his forebears. The result has been a backward-looking viewpoint that has effectually stifled progress and development, but at the same time maintained the existing civilization through long periods practically unchanged.

ANCIENT WALL A MODERN WONDER

In three types of construction the ancient Chinese engineers showed great skill. The best known of these is their building of walls; another is the construction of canals; and the third, which has not received the prominence which its importance justifies, is the building of irrigation works.

A Chinese Foundry

Perhaps the most widely known feature of China is the Great Wall, shown in the photograph. It has a length of about 1,500 miles and is, in volume of material, without doubt the greatest structure built by man. Figure 2 shows a map of China and the Great Wall, superimposed, with the same latitudes, on the eastern part of the map of the United States. Only 18 provinces of China are included, for if its dependencies were added, it would exceed the United States in area. We can best appreciate the length of the Great Wall by considering it in terms of distances in the United States. Beginning at Pittsburgh (Fig. 2) it traverses Ohio, Indiana, Illinois, Missouri, and Oklahoma, ending in the northwest corner of Kansas.

The Great Wall

Its construction began in the second or third century B. C. (Fig. 1). In the sixteenth and seventeenth centuries it was repaired and extended 300 miles. It was built as a means of protection against the warlike tribes to the north and its location was dictated by strategic considerations. Frequently it follows the tops of the ridges, as illustrated. At important points there are duplicate or triplicate walls. Although the wall itself is today of little military significance, some of the important passes it guarded are still strategic points. Its height is usually 20 to 30 ft., the thickness at the base 15 to 25 ft., and the top width 12 ft. In the valleys and passes it is built of stone and brick with watch towers at intervals of about 200 yd. In the more inaccessible places, where a failure of its defense would not allow an invading army to swarm in suddenly, it is built less substantially, sometimes being composed only of boulders and earth.

CITY WALLS ALSO NOTEWORTHY

In general appearance and construction the Great Wall differs little from the walls which surround hundreds of Chinese cities. Outside most city walls there is a moat, reminiscent of the old castles of our ancestors, and some of them are of considerable length, that around Nanking being about 20 miles long. The typical city wall is of brick, but stone is sometimes used and combinations of stone and brick are often found. In some sections mud walls are common.

City walls are frequently composed of two brick retaining walls with a filling of earth between, but sometimes only one brick section is used, backed on the side toward the city by an earth fill. Although these walls are rarely more than 30 ft. high, at one point in the wall around Nanking, the present capital, there is a section about 50 ft. high, which acts as a retaining wall, the land inside being level with the top of the wall. In several of the more progressive cities these walls are being torn down and the brick used in other construction, while the site is turned into a roadway.

CANAL SYSTEM REPLACES HIGHWAYS

With the possible exception of the Great Wall, the greatest engineering works in China are the canals. Their development is especially extensive in the Yangtze delta, a region formed in a somewhat different manner from the typical delta, such as that at the mouth of the Mississippi. The mean range of the tide at the mouth of the Yangtze River is about 7 ft. With the rise of the tide the water rushes up the river and, at the ebb, it flows out again, creating a great estuary. The silt brought down by the river is not deposited by it directly on the land but is carried out to sea to be washed up later by the waves and tides to form the land. Since this depositing is carried on only at high tide level, or a little above, the land was built up a few feet above high tide, and thus formed a great level plain.

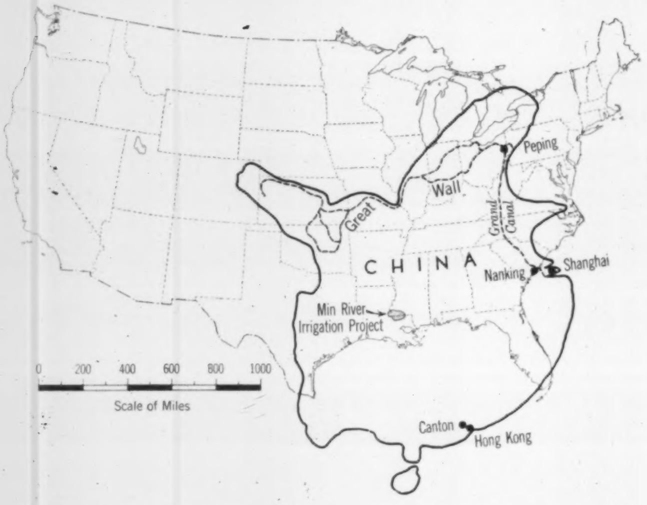

Peping
Great
Wall
Grand Canal
CHINA
Nanking
Shanghai
Min River Irrigation Project
Canton
Hong Kong
0 200 400 600 800 1000
Scale of Miles

FIG. 2. RELATIVE SIZE AND LATITUDE OF CHINA AND UNITED STATES
Showing Extent of Great Wall and Grand Canal

It is doubtful if any region has a more extensive system of canals than this portion of China. The principal canal routes correspond to the primary highways of our populous states and the number of minor canals would equal or might exceed the township and private roads in this country. In some places, the canals pass through cities so numerously as largely to take the place of streets, as shown in a typical view of Soochow, the Venice of China.

GRAND CANAL TRAVERSES EASTERN CHINA

Most important of these waterways is the Grand Canal, or "Transportation River," as it is known to the Chinese. For centuries this great canal exceeded in magnitude any hydraulic engineering feat of Europe or America. Its length of about 1,200 miles makes it still the longest canal in the world. It connects Hangchow with Tientsin, about 850 miles distant (Fig. 3). When superimposed on the map of the United States (Fig. 2) it extends from Charleston, South Carolina, northward through North Carolina, Virginia, and West Virginia, and ends in Ohio, just west of Pittsburgh. It was built piecemeal, the oldest parts extending so far back into antiquity that there is no record of their construction (Fig. 1). From the writings of Confucius, it is known that part of the canal existed in 486 B. C. The last section was completed in 1283 A. D. The period of construction was thus at least 1,769 years.

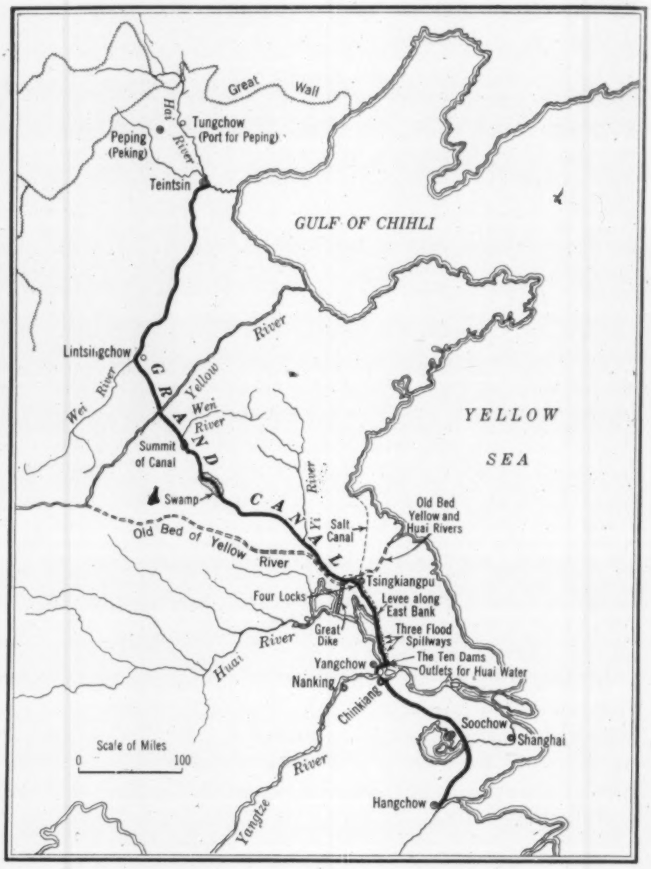
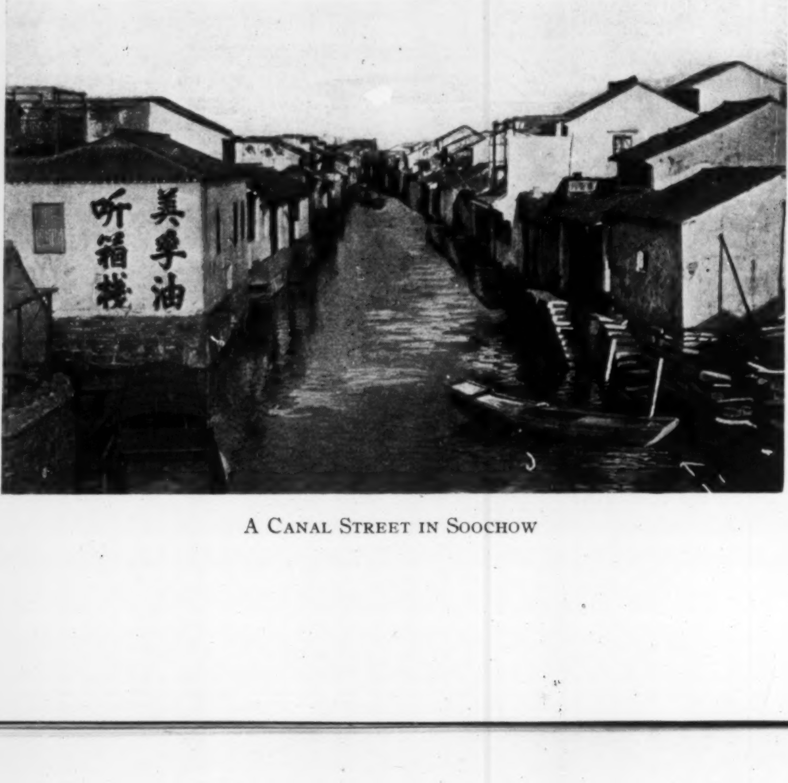

Great Wall
Hai River
Peping (Peking)
Tungchow (Port for Peping)
Teintsin
GULF OF CHIHLI
Lintsingchow
GRAND CANAL
Yellow River
Wei River
Wen River
Summit of Canal
Swamp
Yi River
Salt Canal
Old Bed of Yellow River
Old Bed Yellow and Huai Rivers
YELLOW SEA
Tsingkiangpu
Four Locks
Levee along East Bank
Great Dike
Three Flood Spillways
Huai River
The Ten Dams
Outlets for Huai Water
Yangchow
Nanking
Chinkiang
Soochow
Shanghai
Hangchow
Yangtze River
Scale of Miles
0 100

FIG. 3. MAP OF THE GRAND CANAL



A CANAL STREET IN SOOCHOW

The canal is naturally divided into four sections. The first extends from Hangchow, at one time the capital of China, about 100 miles southwest of Shanghai, to Chinkiang, which is on the Yangtze River about

150 miles above its mouth. This section was built early in the seventh century. The land here is very level and, for the most part, the canal is deep and wide, with very little current. Its construction offered few problems from an engineering standpoint. The banks are frequently covered with stone paving, and beautiful arch bridges span it. Many native boats and small tug boats towing a string of other craft navigate this section, and great rafts of bamboo from the hills near Hangchow move along at a snail's pace.

Irrigation Sluice in the Grand Canal Bank

OLDEST PART IS MOST INTERESTING

On the north bank of the Yangtze River across from Chinkiang, the second section begins, extending north to the old bed of the Huai and Yellow Rivers at Tsing Kiang Pu, a distance of about 100 miles. This is the oldest portion of the canal and, in many respects, the most interesting. The flow is said to have been, in ancient times, toward the north but now, except in the very lowest part, it is always southerly.

For several miles above the Yangtze the banks of the canal are paved with a layer of rubble stone in cement mortar. This work was done in recent years but the layer is very thin and, as it lies directly upon the fine silt, the smallest hole through the revetment allows the wave action of the passing boats to wash a depression beneath it and the rubble cracks and sinks in, thus further exposing the easily erodible bank beneath. A few miles above there is an S-bend which often puzzles travelers, since it would seem such an obvious improvement to cut it off. The purpose of this bend is to increase the length of the canal and thus decrease the slope as otherwise, under certain conditions, the velocities would be so high that navigation would be difficult.

Typical View of Grand Canal

Next comes the old and famous city of Yangchow, which at one time was governed by Marco Polo, the great Italian explorer. Until 20 years ago Marco Polo would have felt quite at home there although the city has been razed and sacked several times since his day. Now he would see many strange things, such as electric lights, telephones, automobiles, and another American invention, the jinricksha. A few miles above the city the canal crosses the drainage route of the Huai River waters, the channels of which in seasons of low water are usually closed by temporary dams.

YANGTZE FLOW DIVIDES

When the Yangtze River is high and little flow is coming down from the Huai River, water flows from the Yangtze up the canal to these outlets, down them and back to the Yangtze again, the canal and the Huai outlets thus becoming, in effect, a part of the Yangtze River system. Upstream from these outlets is located one of the most interesting sections of the waterway. The east bank is a great levee which protects the rich agricultural land between the canal and the Yellow Sea from the waters of the Huai River. If one travels during flood times he can sit on the deck of his boat and look far out over the low country. Even at low water the canal level is higher than the land to the east, and many masonry sluices and culverts discharge the canal water to irrigate this rich land. To the west of the canal is a series of lakes bordered by low land over which the Huai water flows in flood time to join the Yangtze. Emergency spillways, which prevent a breach in the levees when the water becomes very high, are located about 17 miles above the temporary dams.

Modern Sluice at Entrance to Salt Canal

This section of the canal carries a heavy traffic of steam launches and native sail boats, as shown in the photograph. A large part of the cargo is salt passing from the beds along the sea coast to the Yangtze River for trans-shipment up the river to the interior. At the upper end of this section are locks built many centuries ago. The date of construction of the first of these is not definitely known but is very probably in the first quarter of the fifteenth century, and thus sometime before that built by the Brothers Domenico of Viterbo in 1481, and those of Leonardo da Vinci in 1487, but later than those said to have been common in Holland in the fourteenth century. The records available do not make clear whether Chinese structures at that early time were operated as modern locks or whether they were simply sluices through which the boats were dragged by windlasses.

NAVIGATION PROVES DIFFICULT

Beginning at what was once the bed of the Yellow River, a few miles above the locks, the third section of the Grand Canal extends to the present location of that stream, a distance of approximately 265 miles. About $4^1/_2$ miles up the Grand Canal from the Old Yellow River bed is the entrance to the Salt Canal, which leads to the salt works along the sea coast, and eventually to the city of Haichow. The flow into this waterway is controlled by a masonry sluice (see the photograph) designed by me and constructed under my supervision.

About 55 miles above this sluice the Grand Canal receives water from the Yi River, a torrential stream rising in the Shantung hills, which brings large floods and considerable quantities of silt into the canal. Farther along, the canal passes through a series of lakes, or swamps, which supply it with most of its low-water flow. The section of the canal above the Old Yellow River is difficult to navigate during most of the year, due to an insufficiency of water supply. At one time the canal was improved by a series of sluice locks, but these have long since fallen into disrepair and in most cases have been abandoned. The summit of the canal is about 30 miles south of the present location of the Yellow River. Here it is joined by the Wen River, the waters of which divide, one part flowing south toward the Yangtze, the other north toward the Yellow River.

At the time this portion of the canal was constructed, the Yellow River was in the southern location, near the locks previously mentioned, and that portion of the flow of the Wen River which turned northward went on to Tientsin. The crossing of the Yellow River is difficult to negotiate, for, except at certain seasons, there is either an insufficiency of water or too great a current in the canal.

The fourth and last section of the Grand Canal, that north of the Yellow River, consists mostly of navigable rivers. At Lintsingchow, about 50 miles north of the Yellow River, the Wei River joins the canal and from this point to Tientsin, where the canal joins the Hai River, the flow is usually sufficient for convenient navigation. In the vicinity of Tientsin, the flow is controlled by a modern regulating works. In the days of the Empire, the tribute fleets passed out of the canal at Tientsin and up the Pei River to Tungchow, the port of Peking, about ten miles east of that city.

MODERNIZATION OF THE GRAND CANAL

Considerable study has been given to the modernization of the Grand Canal. Such studies include those made of the section in Chihli and Shantung Provinces, under the supervision of the American International Corporation, and those for Kiangsu Province north of the Yangtze River, by the Kiangsu Grand Canal Improvement Board. The section south of the Yangtze is not in such urgent need of repair, and since it passes through a locality already fairly well supplied with transportation facilities, it has not received much attention.

TEARING DOWN THE CITY WALL OF NANTUNG CHOW

Very little progress toward actual construction has been made in any section, however, due to the unsettled condition of the country, which has inhibited the construction of the modern improvements so badly needed in China and has resulted in the loss of needed structures through acts of war or through failure to repair or maintain structures requiring attention. The Grand Canal passes through much of the disturbed country, and long-distance journeys upon it are uncertain of completion and, at times, may be dangerous to life and property.

CONDITIONS WARRANT IMPROVEMENT

Another factor which is important in inhibiting the flow of goods and the free exercise of trade and intercourse is the imposition of taxes on goods in transit past the strongholds of military leaders. No merchant shipping goods by canal from Tientsin to Hangchow can know, at the time his goods leave, the price he must pay in Tientsin in order that he may make a profit on the sale price in Hangchow, or whether the goods will arrive. It is easily understood that the continuation of such conditions is not conducive to the promotion, creation, or support of organizations capable of maintaining the existing structures on the Grand Canal.

There is no doubt that the improvement of at least certain sections is economically sound and will be carried out in the course of time. In spite of the complication of the Huai River floods, the improvement of the section in Kiangsu Province, north of the Yangtze, is a comparatively simple problem, although the actual form which the improvement will take depends on what may be done to solve the flood control problem.

Professional Status of the Engineer

The Certification of Engineers by Our Major Engineering Societies

By W. E. Wickenden
President, Case School of Applied Science

THE engineer who considers his calling to be a profession will be interested to learn the obligations he has assumed to justify so high a status. A professional man must, of course, possess special knowledge and skill and the ability to exercise them but, of equal or greater importance, he must possess altruistic characteristics and he must conform rigidly to a code of ethics of a high order.

President W. E. Wickenden, recently director of the investigation of engineering education for the Society for the Promotion of Engineering Education, is among the highest authorities capable of speaking on this subject. This is a portion of an article read by him before the annual meeting of this society, held in Cleveland, Ohio, on July 9, 1930. Extracts from the article have been published in the September issue of "Proceedings," Part II.

OF PROFESSIONS there are many kinds: open professions like music, to which any man may aspire within the limits of his talents, and closed professions like medicine, which may be entered only by a legally prescribed process; individual professions like painting, and group professions like law, whose members constitute "the bar," a special class in society; private professions like authorship, and public professions like journalism; artistic professions like sculpture, and technical professions like surgery. Despite these differences, all these callings have certain attributes in common, which constitute the professional stamp.

If one seeks definitions, he finds three characteristic viewpoints. One man says that it is all an attitude of mind, that any man in any honorable calling can make his work professional by an altruistic motive. Another says that it is a certain type of work, the individual practice of a certain science or art which has come to be regarded conventionally as professional. A third says that it is a special order in society, a group of persons set apart and specially charged with a distinct social function, as the bar, the bench, and the clergy. Another source of confusion arises from the fact that some view the question solely in terms of ideals and others in terms of practices.

All authorities recognize that some of the attributes of a profession pertain to individuals and some to groups, but there is considerable variation in the emphasis given:

ATTRIBUTES OF INDIVIDUAL PROFESSIONAL LIFE

1. A type of activity marked by high individual responsibility and dealing with problems on a high intellectual plane
2. A motive of service as distinct from profit
3. A motive of self-expression which implies a joy in one's work and a single standard of workmanship, one's best
4. A conscious recognition of social duty to be accomplished, among other means, by:
    - *a.* Sharing advances in professional knowledge
    - *b.* Guarding the standards and ideals of one's profession, and advancing it in public understanding and esteem
    - *c.* Rendering gratuitous public service, in addition to ordinary professional service, as a return for special advantages of education and status

ATTRIBUTES OF GROUP PROFESSIONAL LIFE

1. A body of knowledge (science) and art (skill), held as a common possession and to be extended by united effort
2. An educational process of professional aims, which implies a constructive share by the professional group in the ordering of education
3. A standard of qualifications for admission to the professional group, based on character, training, and competency
4. A standard of conduct in relations with clients, colleagues, and the public, based on courtesy, honor, and ethics
5. A recognition of status by colleagues or by organized society, as a basis of good standing
6. An organization of the professional group based primarily on common interest and social duty, rather than economic monopoly (not universal in the artistic professions).

The earlier professions originated in priestcraft in remote antiquity. What is professional in engineering, however, can be traced only to the medieval merchant and craft guilds. These arose in the period of breakdown of feudal society, at the beginning of the modern commercial and industrial era. It was a period of disintegration and remaking of the social order, before cities had grown strong or central governments had become powerful. Police powers had not been developed by the state. In the gap there grew up self-regulating groups. Commerce and trade could exist only by mutual protection, and this in turn entailed monopolistic control. Furthermore, the religious philosophy of the Middle Ages, which regarded society as a commonwealth divided into divinely ordained functions, discouraged individualism and favored group activity. When the cities and states waxed powerful, they usually confirmed the monopolies which the guilds had acquired, but sought at the same time to regulate them in the public interest. The guilds regulated by ordinance the hours of labor, the terms of apprenticeship, and the quality of workmanship; they required members to contribute periodically to a common fund for the relief of distress, to participate in certain religious observances, and to honor certain festivities and pageants.

Many of these features are perpetuated in the modern professional body. The public grants it more or less tangible monopolies and privileges, in consideration of which it engages to admit only men of proved competency, to scrutinize the quality of their work, and to protect the public against extortion and bungling. The occasion which calls for professional service often represents a human emergency. The knowledge or skill involved is often too esoteric to be judged by an ordinary layman. In many cases the safety of life and limb or the preservation of public health or morals is at stake. Under these conditions the legal doctrine of *caveat emptor*, let the buyer beware, breaks down. The public puts the burden of guaranteeing at least certain minimum standards on the profession itself, and in return protects the profession from incompetent criticism by laymen.

PROFESSIONAL RESPONSIBILITIES

Since a profession must so largely govern itself, it is assumed to maintain certain codes:

1. A code of qualifications governing admissions
2. A code of ethical practices in relations with clients
3. A code of professional honor in internal relationships
4. A code of public obligations

Professional status is therefore an implied contract to serve society in consideration of the honor, rights, and protection society extends to the profession. Through all professional relations runs a threefold thread of accountability to colleagues, to clients, and to the public. Business moves toward the professional area as its management passes from proprietors to a distinct administrative caste with little or no immediate stake in the profits of trade. In so far as the rewards and status of this caste rest on long-range prosperity rather than quick returns, it is able to maintain the attitude of accountability to investors, workers, customers, and the public, which is the irreducible element in professional standing. Whatever of social loss has resulted from the blurring of the engineer's personal status, has been largely offset by what he has contributed as an administrator to the professionalizing of industry.

The obligations of a profession are so much a matter of attitude that codes alone are not sufficient to sustain them. Equal importance attaches to the state of mind known as professional spirit, which results from associating together men of superior type, and from their common adherence to an ideal which puts service above gain, excellence above quantity, self-expression above pecuniary incentives, and loyalty above individual advantage. The professional man cannot evade the responsibility to contribute to the advancement of his group. His skill he rightly holds as a personal possession, and when he imparts it to another he rightly expects a due reward in money or service. His knowledge, however, is to be regarded as part of a common fund; hence the obligation to publish researches and to share advances in professional practice. If his abilities do not permit him to do so personally, he can at least pay his debt by contributing financially to the dissemination of the works of others.

Many engineers need to be warned away from too short-sighted an attitude in this matter. There are doubtless thousands of us to whom the immediate, tangible value of the publications of a professional society is much less than their cost, yet when one pauses to consider the magnificent body of knowledge which has been accumulated as a common heritage through this channel, our tax for the benefit of the art is actually nominal.

DEMOCRACY OF ENGINEERING PROFESSION

Against these backgrounds, let us now consider briefly four of our current problems:

1. Should we seek to divide the profession into distinct strata, or maintain an inclusive form of organization?
2. Should we look to the public or to ourselves to set up and maintain our professional standards?
3. Shall we narrow the doors of access to the profession?
4. Shall we impose more rigid standards on the colleges?

Frankly, we are not ready to settle any of these issues, and the writer expects to raise more questions than he will answer. The healing art is a realm of stratified professions—specialists of numerous sorts, and general practitioners, physicians, and dentists, laboratory technicians, pharmacists, optometrists, nurses, midwives, etc. One does not graduate from one level to another; he selects a particular calling, prepares himself for it specifically, and follows it permanently. This definite grouping contributes greatly to professional standing. A physician is definitely a physician, and no one can escape the fact. As engineers, our traditions are precisely the reverse: between our ranks there exists a high degree of vertical mobility; our organizations have been inclusive in membership, and our education has aimed at the widest range of individual adaptability. In this sense we are the most democratic of all recognized professions. Engineers have the widest possible choice of activities, without impairing their connection with the profession, and the smallest chance of public distinction as members of a professional aristocracy. On the other hand, our inclusive ideals and forms of organization tend to the neglect of our less advanced groups. Draftsmen, for example, would be fairly certain to get more service and economic aid from an organization of their own. Is our attempt at extreme democracy worth its cost? I leave this question open.

LICENSING AS A PANACEA

The movement for public licensing of engineers has reached such proportions as to bring to a focus the question whether we are to look to the public or to ourselves to set and maintain our professional standards. Licensing, as developed in other professions, is primarily for the protection of the public. People need the services of doctors, dentists, and lawyers in personal emergencies when they are least able to discriminate between the competent, ethical practitioner and the shyster, quack, or imposter. Incidentally, licensing tightens the monopoly of a profession and aids it in restricting accessions.

How much protection does the public gain from the licensing of engineers? Some, undoubtedly, and perhaps much in the non-industrial areas where few persons have any real knowledge of engineering standards and personnel, and where individual practitioners and partnerships still dominate. Under these conditions the engineers receive much the same degree of protection as the public. Where engineering practice is largely corporate, rather than individual, licensing affords only nominal protection to either side. In structural practice, where the engineer comes into contact with the architect, it is essential that regulations imposed on the one shall not infringe the rights of the other. If one is licensed and given certain privileges, it is fairly imperative to do the same for the other. Our profession has little need of restrictive measures to curtail its numbers. The number of doctors or lawyers required per million of population is fairly inherent, but we are still far from the limit of society's capacity to use men who apply the resources of science to economic processes and utilities.

As a means of raising professional standing, the results of licensing have been practically negative. It may have kept out a few shysters who might have survived in a state of free competiton but it has left the general level of the profession unaltered and its boundaries vaguely defined, as shown by the mere fact that it has accepted the status quo and written it into legal regulations. In my opinion, licensing is a fact to be accepted, but not one of major consequence to the profession. It is alien to our best traditions and to the philosophy on which our profession rests. Our British brethren, I believe, manage the whole matter better within the profession by making their codes of qualifications definite, impartial, and significant.

FIXING OF EDUCATIONAL STANDARDS

Our engineering colleges and engineering societies sprang from different roots, and have developed independently of each other. Educators, in the sacred name of academic freedom, have favored "hands off" and the societies have felt, apparently, that *laissez faire* was the best policy. On the whole, the policy has worked reasonably well. Engineering education has been kept out of any such strait-jacket as that which encases the medical schools; it has been free to experiment, to evolve new types, and to adapt itself to the needs of different sections of our population. If anything, its self-standardization has been too conventional, too much tinged by imitation, and by the desire to proclaim every prairie state college "the same as Cornell," or every Y. M. C. A. school a "university."

The right of the profession to regulate, it seems quite clear, is limited to accepting in full, accepting with a discount, or rejecting in full the credentials of any so-called engineering college as partial fulfillment of the requirements for membership. The opportunities of the profession seem to lie in the more intangible second mile, where guidance and stimulation replace regulation. May I suggest a few matters on which such guidance would be appropriate?

ORGANIZATION OF ENGINEERING COLLEGES

Do we need more than one type of engineering school? Should there be some with two-year programs, some with four, and some with five or six; some with essentially practical programs, and some highly scientific? Should the division of this field be left to free competition and local enterprise, or can some balance be kept through advisory action? Should colleges award professional degrees? If so, should the award be based on some form of sanction by the profession? Should the profession, as a body, supply incentives and recognition for the after-college education of the engineer? In view of the open character of our profession, can we hope to give its members an effective, individual status without a much more definite code of educational qualifications? Should these be uniform or graded?

CERTIFICATION THE SOLUTION

Specifically, I would like to advocate one measure. It is in no sense a cure-all, yet it would help in some degree toward the solution of each of the problems which has been discussed. This measure is the certification of engineers by our major professional societies. I would favor keeping the profession open, not making it a legal monopoly, and I would let licensing laws run their course until they find the level of their inherent limitations. I would keep our membership inclusive and not too rigidly graded, granting to engineers who pass into administrative duties the full fellowship of the profession. I would keep educational doors open in even greater variety, with a minimum of regulation and a maximum of guidance by the organized profession. All this is broad church doctrine, in harmony with our history and traditions, and all good as far as it goes. But the profession needs more than an open association of like-minded men; it needs an inner nucleus of highly qualified men whose professional standing and standards the public cannot possibly mistake. A plan of certification by the profession is a task for many men to work out, and not for one. May I suggest, however, the following features:

1. Certification should be earned, and not granted as a mark of honor.
2. There should be a code of educational qualifications more advanced than mere graduation from college, yet attainable by both college and non-college men.
3. These qualifications should be tested individually and not gaged by personal estimates and testimonials alone.
4. Educational qualifications should comprise scientific, technical, economic, and civic knowledge of a mature order.
5. There should be a code of experience qualifications which would normally make the age of certification fall between 25 and 30.
6. The certification of graduates should be the goal to which the colleges and the professional societies would bend their influence. To this end the colleges should be encouraged to limit the award of professional degrees to those who have previously been certified.

COLLEGES AWAIT CHALLENGE

The protection of professional standards and the enhancement of professional status is a prime duty of the profession itself and ought not to be allowed to pass by default into political hands, or into forms little calculated to enhance the dignity and prestige of the engineer. There is a certain appropriateness in the advocacy of this cause by one connected with the educational arm of the profession. What the colleges are waiting for is a challenge from the profession, not merely to perfect their present undergraduate courses, but also to attack in earnest our next great problem, the after-college education of the engineer.

Economical Method of Breaking Moderate Frost by Means of "Skull Cracker"

Output Factors for Excavation and Material-Handling Equipment

By A. E. Holcomb
Member American Society of Civil Engineers
Sales Engineer, National Equipment Corporation, Milwaukee, Wis.

SO MANY variables enter into the computation of the possible yardage that may reasonably be expected under different conditions, when excavating or rehandling materials, that it is impossible to set down any hard and fast rules for making prior estimates. Certain fundamental principles, however, pertaining to operation should be borne in mind. As the fruits of many years of experience and observation, a series of numerical multipliers has been compiled based on average results obtained from known conditions of work and in different materials.

BASIC LAWS INVOLVED

It is hoped and believed that a knowledge of the principles evolved and of their application will be helpful to all engineers and contractors. In all earthwork handled by machinery the following principles are fundamental:

1. The shorter the time required to fill the dipper or bucket, and the longer the arc of swing from cut to dumping point, the more important becomes the size of the dipper or bucket, the width of its cutting edge, and the ability to fill it properly.

2. Inasmuch as output is the product of the number of bucket loads handled in a given time and the average size of the load, endeavor should be made to increase both the number and size of the loads handled.

3. It is not economical to increase the number of loads at the cost of their size unless such increase is proportionately greater than the decrease in the size of the load handled. Of course, the converse also is true.

4. The operating cycle consists of the loading time, the swinging (or hoisting and swinging) time, the dumping time, and the time required to return the bucket to the loading point. Time studies should be made to determine and reduce time losses. In particular, the work should be arranged so that the shovel, crane, or drag line is not delayed at the dumping point.

5. When loading trucks or cars, every effort should be made to move them forward during, or as nearly as possible within, the period of the dipper or bucket operating cycle.

REGARDING earthwork and material moving, the principal information obtainable has been yardages that were handled under certain, what might be termed, "parlor conditions," not at all representative of the average. As a result there has been a lack of understanding between the engineer and the contractor. The young engineer, educated by misleading information, expects too much work to be done in a given length of time and does not make proper allowances. The older engineers, of course, have acquired, according to their opportunities, more of accurate information. All who have excavation problems will be rewarded by a close study of Mr. Holcomb's paper. Fruits of a rich experience are here made available.

6. All factors—especially overhead, operating expense, and conditions of the work—being equal, that type of machine shovel, crane, or drag line should be used which will handle the greatest amount of material in a given time. In practical operation, a certain machine may prove to be economical in one case but not in another; therefore, a study of each job should be made to determine its limiting conditions and the proper machine to use.

7. Again, the height of hoist should be the least possible. In bucket-crane work particularly, the shortest length of boom that will do the work should be used.

8. In laying out the work, other

conditions being equal, it is imperative that the average arc of swing be reduced to a minimum, as shown in Fig. 1.

9. If the material to be excavated is so hard that the digging is difficult and expensive, blasting should be resorted to whenever its cost becomes less than the cost that would accrue by reason of delays to the shovel and hauling equipment, plus extra repairs to the shovel. An alternative method for mild frost conditions is illustrated in the cut at the head of this article.

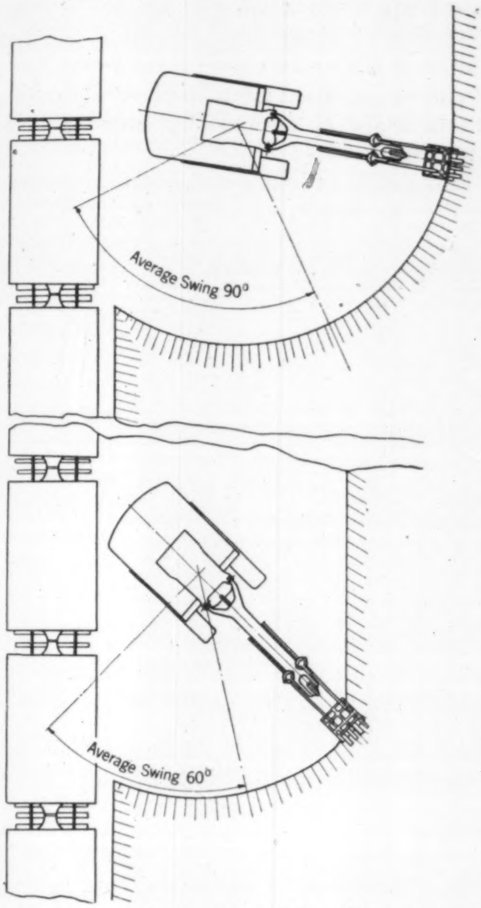


Fig. 1. Comparison of Average 90° Swing with 60° Swing Requiring More Move-Ups

10. It will be more profitable to work equipment than to leave it idle whenever the price that can be obtained for the work exceeds the operating cost plus the depreciation and operating overhead, less the idling depreciation and overhead (including, of course, the cost of maintaining the organization while idle). Any excess whatever helps by that much to cut down the continuous carrying charge. Such work, at a price below the total cost, should be undertaken, however, only when it can be finished before, or left as soon as, a profitable job is obtained.

Mats Used in Sandy Clay

11. Every organization should determine its individual coefficient or output multiplier. This will depend on several factors, such as the management of the work; the placing and handling of equipment; the attention given to the upkeep of equipment; the balance maintained between the several types of equipment used, so that no one type becomes a restraint upon the others; the efficiency of the personnel and equipment; and the extent of the cooperation between the several members and units of the organization. When this comparative output coefficient has been determined, it should be used in the making of estimates to diminish or increase the yardage output to be expected.

At times, of course, reasons of expediency may make it desirable for an organization to work on certain jobs with equipment, or under conditions which, for those jobs, will give a low output coefficient. This should be taken into consideration in making the prior estimate.

12. The cheapest investment any organization can make is to pay such an adequate and reasonable salary as will secure the services of a skillful, fast, and careful operator, who will take an interest in his work and study it to obtain a maximum output at a minimum cost.

BASIC LAWS IN OPERATION

Principle No. 8 may readily be proved by the following example:

A reasonably good operator, working in non-sticky material under favorable operating conditions, with a swinging speed of 4 r.p.m., an average swing of 90 deg., and no delays, can take out from 3 to 4, or, say, easily 3 bucket loads per min. The time rate will be: 60 ÷ 3 = 20 sec. per load.

A reduction of 30 deg. in the average arc of swing from cut to dumping point will effect the following saving in the swinging time:

$$\frac{2 \times 30 \text{ deg.} \times 60 \text{ sec.}}{360 \text{ deg.} \times 4 \text{ r.p.m.}} = 2.5 \text{ sec. with each dipper or}$$

bucket load.

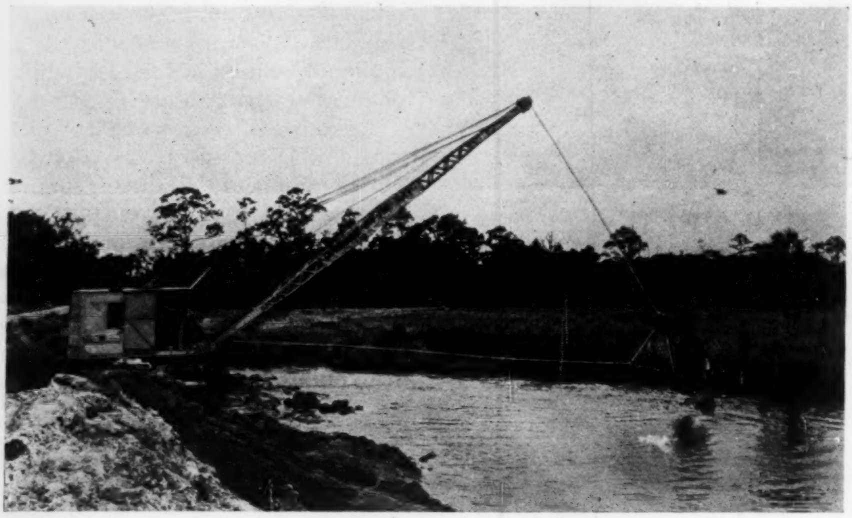
That is, there will be a gain of one dipper or bucket load with every eight taken out. Look at it in another way: a "move-up," or forward traction movement of the machine on the work, normally consumes about 15 sec. Then the gain in swinging time is equivalent to an extra move-up for each six dipper or bucket loads. Therefore, it will always pay to reduce the arc of swing by 30 deg., provided the quantity of material taken out per move-up is not reduced more than six dipper loads.

In the same way, also, an increase in the swing from 90 deg. to 180 deg. between the cut and the dumping point will require:

$$\frac{2 \times 90 \text{ deg.} \times 60 \text{ sec.}}{360 \text{ deg.} \times 4 \text{ r.p.m.}} = 7.5 \text{ sec. longer time for each}$$

dipper or bucket load.

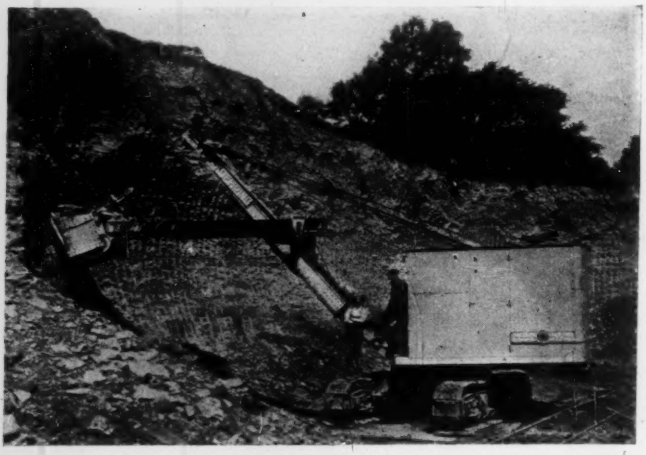
Then, $\frac{20}{20 + 7.5} = 0.73$ will be the theoretical output multiplier, giving the reduction of volume due to the increased swing. However, because of delays, or because the bucket may not always fill properly, it is safe to assume that the total output actually will not be reduced more than 20 per cent, instead of the 27 per cent indicated. Application of these multipliers by the individual will quickly enable him accurately to estimate such variations as appear in specific problems.



CASTING EMPTY DRAG-LINE BUCKET

QUICK YARDAGE COMPUTATIONS POSSIBLE

An idea of the approximate average yardage that can be excavated by machinery under favorable weather conditions, and under the working conditions described, is given in the accompanying tabulations of multipliers. They are only averages which a reasonably good operator, under favorable weather and ordinary working conditions, should be able to maintain, with proper cooperation from an efficient management.



HIGH-BANK DIFFICULTIES OVERCOME

Unquestionably, these capacities could be, and very frequently would be, greatly increased for a single day or for several days in succession. Every contractor knows, however, that on some days there are annoying hindrances which cut down the output. If there is no transportation or other delay, so that the material is taken away as fast as the shovel excavates it, the yardage output can be increased from 15 per cent to 35 per cent over the average as affected by unusual weather or operating conditions.

For instance, in ordinary earth, with a modern shovel having a 1-yd. dipper, an output of 1,200 cu. yd., and more, has frequently been obtained in a 10-hr. day; whereas, on other days, due to muddy conditions and waiting for trucks, or for some other reason, the day's output may be only 500 cu. yd., or less. Thus, the capacity in which the contractor is really interested is the average and not the yardage that can be taken out on one particularly favorable day.

In the preparation of estimates, this brings in the modifying elements of local, seasonal experience and unknown risk, for which allowance must be made. It will be readily apparent that in making up the accompanying lists of multipliers, prolonged wet weather, frost, and other "acts of God," or exceptional conditions surrounding the work, could not be taken into consideration because of their uncertainty.

There are so many gradations or shadings from one condition of work or kind of material into another that good judgment must be used in each case. This must be based on a knowledge of the particular work, the equipment to be used, and the organization.

For a combination of conditions, such as material, depth, and swing, the resulting factor will be the product of the several individual multipliers in Tables I and II. The methods illustrated in the examples are perfectly general and can be applied to any of the machines or materials listed. For brevity, the numerical applications have been distributed among the various methods of handling materials, although applicable to each.

POWER-SHOVEL OPERATION STANDARDIZED

The accompanying multipliers for different conditions of work, and for different kinds of material to be excavated or handled, are based on certain primary assumptions determined from years of experience and observation, as follows:

Assume, as a basis from which to start calculations, that operating conditions are reasonably favorable;

that a 1-yd. dipper is being used; that ordinary earth is being excavated from an 8-ft. cut; and that trucks or cars are being loaded at the side of the machine, so that the swing of the dipper would be between 45 deg. and 135 deg., or an average of approximately 90 deg. Under such working conditions, the operator should ordinarily be able to take out from 96 to 105, or, say, approximately 100 cu. yd. per hr., place measurement. Table I is a list of multipliers, or output coefficients, for shovels. The high bank illustrated in one of the photographs on page 28 is approaching the upper limit as to depth of cut for such machines.

Table I. Multipliers or Output Coefficients for Shovels

Material	Multiplier	Depth of Cut	Multiplier
Hard shale and other rocky formations poorly blasted	0.40	0 ft. 3 in.	0.33
		0 ft. 6 in.	0.50
Fairly well-blasted rock or hard-pan, and tough, rubbery clay	0.50	1 ft. 0 in.	0.62
		1 ft. 6 in.	0.72
Clay and boulders	0.60	2 ft. 0 in.	0.80
Heavy clay (not sticky)	0.70	3 ft. 0 in.	0.85
Clay gravel	0.80	4 ft. 0 in.	0.89
Wet, sandy clay	0.90	5 ft. 0 in.	0.93
Ordinary earth	1.00	6 ft. 0 in.	0.96
Light, dry loam or clay, loose sand and gravel, cinders, or ashes	1.10	7 ft. 0 in.	0.98
		8 ft. 0 in.	1.00
Light, moist clay and loam	1.25	9 ft. 0 in.	0.97
		10 ft. 0 in.	0.94
		11 ft. 0 in.	0.91
		12 ft. 0 in.	0.88
Size of Dipper		13 ft. 0 in.	0.85
		14 ft. 0 in.	0.82
½ yd.	0.50	15 ft. 0 in.	0.79
⅝ yd.	0.63	16 ft. 0 in.	0.76
¾ yd.	0.75	Side casting	1.25
1 yd.	1.00		
1¼ yd.	1.25	Loading trucks in rear, 180° swing from cut	0.80
1½ yd.	1.50		

These multipliers (Table I) are based on an assumption of the following speeds:

Swinging	4 rev. per min.
Hoisting (2-part line)	80 ft. per min.
Crowding	110 ft. per min.
Racking-in	160 ft. per min.

For larger machines carrying larger dippers the most economical depth of excavation would increase. Similarly, the depth multipliers would have to be changed somewhat.

Where slopes have to be trimmed when computing yardage in cut, take for purposes of estimate 1 ft. 0 in. of material over slopes as separate yardage. Then, for this yardage, the multiplier would be approximately:

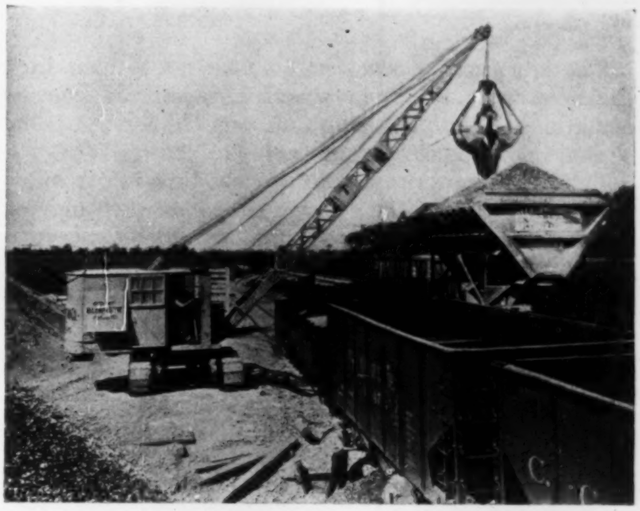
For 1:1 slope	0.60
For 1.5:1 slope	0.40

In moving up, a shovel mounted on crawlers usually loses about 15 sec. This is taken into account on an average basis in establishing the original hourly yardage. Where the terrain is so soft, however, that mats are required, as shown in one of the cuts, the average time loss, when moving up, will be approximately 1 min. The effect on the yardage output of this extra moving time will depend on the ratio of the excavating time to the sum of the excavating time plus the moving time.

PRACTICAL POWER-SHOVEL COMPUTATIONS

Assume a 1¼-yd. dipper, grading a mountain roadway through fairly well-blasted rock, with a 1½-ft. cut, and loading trucks behind the machine. The output coefficient will be: $1.25 \times 0.50 \times 0.72 \times 0.80 = 0.360$, resultant multiplier. Then, the output will be: 0.360×100 cu. yd. $= 36.0$ cu. yd. per hr.

Or, assume a 1½-yd. dipper excavating wet, sandy clay from a 5-ft. cut, loading cars at the side. The shovel moves on mats, the average yardage excavated between moves being 20 cu. yd. The output coefficient will be $1.50 \times 0.90 \times 0.93 = 1.25$, the resultant multiplier. The original assumption was 100 cu. yd. excavated in 60 min. Then, $\frac{20 \times 60}{100 \times 1.25} = 9.6$ min., the excavating time between moves. Allowing 1 min. total moving time on mats, minus 15 sec., or ¼ min. already allowed in the original yardage assumption, will give $\frac{9.6}{9.6 + (1 - 0.25)} = 0.927$, as the job multiplier because of having to move on mats. Then, the yardage rate will be $1.25 \times 0.927 \times 100 = 115.8$ cu. yd. per hr.



Transferring Material with Clamshell Bucket

DRAG-LINE EXCAVATION ALSO STANDARDIZED

Table II. Multipliers or Output Coefficients for Drag-Line Work

Materials	Multiplier	Depth (End-Cut of Excavation)	Multiplier
Fairly well-blasted rock or hard-pan	0.40	1 ft. 0 in.	0.820
		2 ft. 0 in.	0.900
Tough, rubbery clay	0.45	4 ft. 0 in.	0.950
Clay and boulders	0.55	6 ft. 0 in.	0.980
Heavy clay (not sticky)	0.70	8 ft. 0 in.	1.000
Clay gravel	0.80	10 ft. 0 in.	0.975
Wet, sandy clay	0.90	12 ft. 0 in.	0.950
Ordinary earth and dry, sandy clay	1.00	14 ft. 0 in.	0.925
		16 ft. 0 in.	0.900
Light, dry loam and clay, loose sand and gravel, cinders, or ashes	1.10	18 ft. 0 in.	0.875
		20 ft. 0 in.	0.850
		22 ft. 0 in.	0.825
Light, moist clay and loam	1.25	24 ft. 0 in.	0.800
		26 ft. 0 in.	0.775
Size of Bucket (assuming medium heavy construction)		28 ft. 0 in.	0.750
		30 ft. 0 in.	0.725
½ yd.	0.50	32 ft. 0 in.	0.700
¾ yd.	0.75	34 ft. 0 in.	0.675
1 yd.	1.00	36 ft. 0 in.	0.650
1¼ yd.	1.25	38 ft. 0 in.	0.625
1½ yd.	1.50	40 ft. 0 in.	0.600
Casting Empty Bucket (beyond point of boom)		Loading trucks	0.80
Depending on the arc of outward swing of bucket	0.85 to 0.75 (say 0.80 as an average)	Dumping at 180° swing from cut	0.80

Assume as a basis from which to start calculations for drag-line work, that operating conditions are reasonably favorable; that a 1-yd. bucket is to be used; that reasonably dry, ordinary earth is to be excavated from an 8-ft. cut; and that the material is to be wasted in a spoil bank at the side of the machine, so that the swing of the machine from cut to spoil bank would be between 45 deg. and 135 deg., or an average of approximately 90 deg. Under such working conditions, the operator ordinarily should be able to take out from 75 to 85 or, say, approximately 80 cu. yd. per hr., place measurement.

The list of multipliers or output coefficients for drag-line work is as given in Table II. These multipliers are based on an assumption of the following speeds:

Swinging	3 rev. per min.
Hoisting	160 ft. per min.
Dragging	120 ft. per min.

The data apply to new work only and not to open-ditch clean-out work, which involves additional and unusual conditions. The photograph on page 28 illustrates one of the conditions covered in Table II.

For drag-line work, as with shovels, time is lost where mats are required; the average time loss when moving back will be approximately $^3/_4$ min., instead of the normal 15 sec.

The amount of sticky material that can be handled depends on how much the bucket is clogged and how often it has to be cleaned.

For side cut in ditching, where the bucket must dig down and trim the bank as well as dig coming up, the multiplier would be 0.95 to 0.90 of the end-cut multiplier (depending on the ratio of the depth to the width of cut and to the working radius) until the depth becomes approximately 0.4 of the working radius; after this, the yardage, except in easy-digging material, would diminish so rapidly as to make it desirable to change to a digging type of clamshell bucket. As before, the use of larger machines and buckets would affect the depth multiplier.

For example, assume a $1^1/_2$-yd. bucket working in ordinary earth, making a 6-ft. side cut, and dumping in a spoil bank with an average swing of 90 deg. The output coefficient will be: $1.50 \times 1.00 \times 0.98 \times 0.95 = 1.396$, the resultant multiplier; that is, the output will equal $1.396 \times 80 = 111.7$ cu. yd. per hr.

Or, assume a $1^1/_2$-yd. bucket working in heavy clay making an 8-ft. side-cut drainage ditch. The material is deposited in a spoil bank requiring, approximately, a swing of 180 deg. from the cut. The drag-line excavator moves along the ditch berm on mats. The average yardage to be excavated between moves is 30 cu. yd. The output coefficient will be: $1.5 \times 0.70 \times 1.00 \times 0.95 \times 0.80 = 0.798$, resultant multiplier. The original assumption was 80 cu. yd. in 60 min. The excavating time will be

$$\frac{30 \times 60}{80 \times 0.798} = 28.2 \text{ min.}$$

If $^3/_4$-min. moving time on mats is allowed, instead of the 15 sec. already used in the original yardage assumption, the resulting coefficient will be $\frac{28.2}{28.2 + (0.75 - 0.25)} = 0.982$, the job multiplier, because of having to move on mats. This gives an output of $0.798 \times 0.982 \times 80 = 62.7$ cu. yd. per hr.

STANDARDIZING CLAMSHELL-BUCKET CRANE WORK

Assume that 50-ton gondola cars, loaded with aggregate, are to be unloaded and the material transferred to a bin 22 ft. high, under ordinary conditions, with a suitable bucket and a reasonably good operator; and that the average swing of the machine will not exceed 90 deg. Then the progress of unloading will be approximately as given in Table III.

TABLE III. NUMBER OF 50-TON CARS UNLOADED PER HOUR, USING A CLAMSHELL-BUCKET CRANE WITH VARIOUS MATERIALS

Size of Bucket in Cubic Yards	Material					
	Sand		Gravel		Stone	
	Loose	Packed	Loose	Packed	Loose	Packed
$^3/_4$	1.6	1.6	1.50	1.40	1.20	0.90
1	2.0	2.0	1.90	1.76	1.50	1.10
$1^1/_4$	2.4	2.4	2.28	2.12	1.80	1.30
$1^1/_2$	2.8	2.8	2.67	2.50	2.10	1.50

Under different conditions the quantities may be obtained by multiplying by the proper coefficients, as shown in Table IV.

TABLE IV. MULTIPLIERS FOR CLAMSHELL-BUCKET CRANE WORK

Item	Multiplier
With Hopper-Bottom Cars Discharging into Shallow Pits—Top of Materials 6 Ft. below Crawlers of Crane	
Clamming from pit to bin	1.00
Clamming from pit to stock pile	1.20
Clamming from gondola car to bin (loose material)	1.00
Clamming from gondola car to stock pile	1.20
Clamming from stock pile to bin	1.30
Clamming from stock pile to car	1.50
From Original Pit to Car	
Pit 4 ft. 0 in. below top of car	1.200
Pit 6 ft. 0 in. below top of car	1.175
Pit 8 ft. 0 in. below top of car	1.150
Pit 10 ft. 0 in. below top of car	1.125
Pit 12 ft. 0 in. below top of car	1.100
Pit 14 ft. 0 in. below top of car	1.075
Pit 16 ft. 0 in. below top of car	1.050
Pit 18 ft. 0 in. below top of car	1.025
Pit 20 ft. 0 in. below top of car	1.000
Pit 22 ft. 0 in. below top of car	0.975
Pit 24 ft. 0 in. below top of car	0.950
Pit 26 ft. 0 in. below top of car	0.925
Pit 28 ft. 0 in. below top of car	0.900
Pit 30 ft. 0 in. below top of car	0.875
Pit 32 ft. 0 in. below top of car	0.850
Pit 34 ft. 0 in. below top of car	0.825
Pit 36 ft. 0 in. below top of car	0.800
Pit 38 ft. 0 in. below top of car	0.775
Pit 40 ft. 0 in. below top of car	0.750
Swinging 180° Instead of 90° to Discharge	0.80

These multipliers are based on an assumption of the following speeds:

Swinging	4 rev. per min.
Hoisting	160 ft. per min.

For example, assume a $1^1/_2$-yd. clamshell bucket moving sand and gravel from a stock pile into a car. The output will be $\frac{2.80 + 2.67}{2} \times 50 \times 1.50 = 205$ ton per hr. At 3,000 lb. per cu. yd., this will be:

$$\frac{205 \times 2{,}000}{3{,}000} = 136.6 \text{ cu. yd. per hr.}$$

CONCLUSION

A celebrated statistician, when asked to prophesy as to the next year's business, stated "It will be a very good year if nothing happens to prevent." In like manner, the results obtained with the mechanical excavation and handling of materials should be reasonably in accord with the foregoing estimates if no contingency prevents. On the other hand, if the engineer will only study the variables incident to his particular job and apply the proper adjustment coefficients as here outlined, the results will more than justify his efforts.

Guiding Principles of the Activated Sludge Process

By T. Chalkley Hatton
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VALUES in sewage have long offered possible rewards as an attraction to sewage treatment. The activated sludge process returns greater values than all other methods. The success of the experiments and of the pioneer activated sludge plant at Milwaukee, as pointed out in this article, are encouraging for the future in solving sewage problems.

Mr. Hatton, who directed the experiments and the construction of the plant at Milwaukee, presented this paper on July 18, 1930, before the Summer School for Engineering Teachers of the Society for the Promotion of Engineering Education at Yale University.

CREDIT for the discovery of the activated sludge process has been generally given to Dr. Gilbert J. Fowler, formerly chief chemist of the Manchester Rivers Board of Manchester, England, and to Drs. Edward Ardern and William T. Lockett, former assistants to Dr. Fowler. In fact, in my early published papers, I gave these gentlemen full credit, but as much broader information became available, due to litigation of the patentees with the City of Milwaukee, I have become convinced that this discovery must be shared with others than those to whom it was first credited.

As far back as 1889, and again in 1892, Messrs. Leonard Archbutt and Richard M. Deeley, two sanitary engineers of Salford, England, patented a process for the clarification and purification of waste industrial liquors which is substantially the same as the activated sludge process. The first patent covered what is now known as the draw-and-fill, and the second the continuous-flow method. Many plants were established in industries throughout England and are still in successful operation.

In 1911, Harry W. Clark, chief chemist for the Lawrence Experimental Station of the Massachusetts State Board of Health, conducted some very interesting experiments upon the aeration of sewage, in which he permitted the aerated sludge to remain in the vessels to seed fresh sewage as and when admitted. His purpose was to increase the purification efficiency of trickling filters. As he progressed in these experiments, he noted some very interesting effects upon the clarification of the sewage by the increase of nitrates and nitrites in the effluents, and reported his findings in his annual reports.

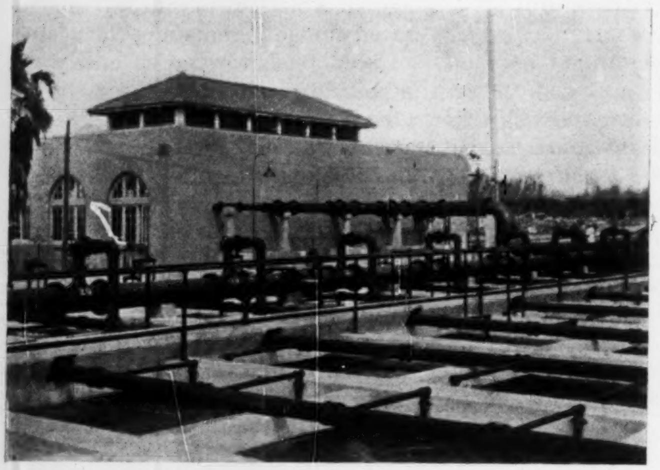
In 1912, Dr. Fowler visited the Lawrence Station, viewed the experiments with great interest, and was so greatly impressed with the results that, when he returned to Manchester, he directed his assistants to repeat the experiments conducted by Mr. Clark. Out of this was gradually developed what has been termed the activated sludge process.

A firm of manufacturing engineers, or rather the president of such a firm, Walter Jones, located in Stourbridge, England, promptly patented all the discoveries which had been made by the several investigators, claiming they were original with Dr. Fowler, and members of his staff. By virtue of transfer of title and by other means, certain individuals in the United States have brought suit against the Cities of Milwaukee and Chicago, and have notified other cities of their intention of demanding

Airplane View of Milwaukee Activated Sludge Plant compensation for infringement of these early patents as secured by Walter Jones. The first suit was brought against the City of Milwaukee. It has been argued before the Federal court, and is awaiting the decision of the judge.

EXPERIMENTAL WORK COMMENCES

Following the preliminary small-scale experiments conducted by Mr. Clark at Lawrence from 1911 to 1914, and by Dr. Fowler and associates in 1913 and 1914, several experimenters in the United States began a more elaborate and intensive study of the process, which has continued since 1914. In Milwaukee the first laboratory experiments were begun early in 1915. As these progressed the apparatus employed was increased in magnitude, until in 1917 experimental tanks of about two-million-gallon capacity were being operated. The several problems involved presented themselves progressively and had to be solved. Among the most important may be mentioned those involving the general characteristics of activated sludge, and the degree to which sewage could be purified by it within permissible costs, as compared with other methods of sewage treatment.



AERATION TANKS AT PASADENA, SHOWING AIR DISTRIBUTION SYSTEM

AIR REQUIREMENT DETERMINED

This study involved the determination of the economical use of air, measured in period and volume of application; the method of application, and best type of apparatus therefor; the depths of sewage in aerating tanks; the reduction of loss in air pressure through air conduits and air diffusers; the size of air bubbles when applied to liquor; the cleaning of air to prevent stopping up the air diffusers; and the relative economy of using air obtained from power compressors or free air from mechanical disturbers in the liquor.

After extended laboratory experiments, with various apparatus for applying air, it was found that a maximum air bubble, $^1/_8$ in. in diameter, was the most efficient, and that a Filtros plate, which when wet would pass 8 cu. ft. of air per min. per sq. ft. of plate, under a pressure due to two inches of water, would produce the proper size of bubble. An air washer was required, preceding the air compressor, to protect the Filtros plates from becoming stopped up by solids carried in the free air. Since operating the Milwaukee plant and other large plants, it appears more economical to use a more porous plate, say, one which will pass about 13 cu. ft. per min. under the same pressure.

In order to obtain uniform air contact throughout the tank liquor, the proper ratio of diffusion area to depth and tank surface had to be determined. Finally a ratio of one to four was used in the main plant. Since then other plants have been built having ratios of one to ten, and as high as one to thirteen, with satisfactory results. In fact, it appears that if the aerating tanks are so built and the diffuser plates so placed as to cause a complete rotary action of the liquor, free of cross currents, the aerating requirements may be effected with less air. The Indianapolis and north-side Chicago plants have been built upon the rotary method.

Experiments were conducted on different types of meters to determine which could be depended upon to measure the volume of air with the least error. Effects upon the process through changes of air and sewage temperatures, as well as the volume of air required by the range between weak and strong sewage were studied. This latter study was made for the purpose of determining whether it was more economical to vary the rate of applying the air in accordance with the changes in the strength of sewage, or to apply it at a uniform rate throughout the 24 hours.

SLUDGE RETURNED TO INCOMING SEWAGE

The activated sludge process involves constant returning to the incoming raw sewage, and intimately mixing with it a certain quantity of the sludge which has passed through the plant. This is for the purpose of furnishing food and lodgement, not only to the nitrifying bacteria already in the raw sewage, but to those enormous numbers which multiply in the mixture of sludge and sewage.

The degree of purification depends somewhat upon the volume and character of this returned sludge. For certain kinds of sewage, measured in organic matter and temperature, the proper quantities of returned sludge are required to get the best efficiency. In a chemically neutral sewage, that is, one having an approximate pH value of 7, carrying as high as 350 parts per million of suspended and settleable solids, a volume of returned sludge equal to 20 per cent of the volume of raw sewage was sufficient. A much larger volume did not interfere with efficiency except that it required more power and more space.

This study proved that if for any cause the excess sludge could not be removed from the plant as rapidly as produced, it might be pyramided through the aerating and sedimentation tanks until it amounted to about 50 per cent of the volume of raw sewage treated, without seriously affecting the process.

DEPTH OF AERATING TANKS DETERMINED

Fifteen-foot depths were found the most efficient for sedimentation tanks, after due consideration of all important factors. In the shallow tanks, it appeared that the same relative volume of air did not effect as good purification in the same period of time, because the bubbles of air remained in contact with the tank liquor for a shorter period than in the deeper tanks. It is worthy of note here that if air is applied to the mixed liquor at the rate, say, of 2 cu. ft. per min., it does not effect the same degree of purification as 1 cu. ft. per min. applied at that rate for two minutes. Thus a slower movement of air through the mixed liquor gives greater efficiency, and from this determination the idea of deeper tanks was evolved.

CHIMNEY CENTERS CREATE AIR FLOW

Several types of tanks were studied. Among them was one having a sloping bottom with so-called chimney centers. That is, a center compartment flared at the bottom and the top and terminating at the surface of the liquor, was built in the center of the tank for its entire length, with the air applied to the liquor at the bottom, immediately under the center of the chimney. The purpose was to create an upward flow of air and liquor, through the chimney, the air escaping at the top, while the liquor passed over the sides laterally toward the walls of the tank, thence downward to be re-mixed with the upward flowing air, thus creating a rotary action.

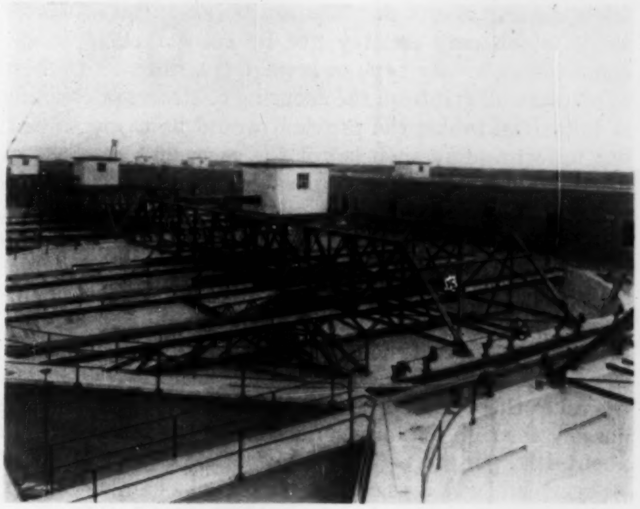
One tank bottom, built of inverted pyramids with a diffuser in the apex, and another with ridges and furrows at right angles to its axis, with the diffusers in the bottom of the furrows, were tested. The latter type gave the best results, both in efficiency and costs, and it was adopted by Milwaukee. Since then a different form of tank has been adopted in the Indianapolis and north-side Chicago plants, which it is claimed is cheaper to construct, requires less air for successful operation, and gives equally satisfactory results.

Sewage, in the average city, which is composed of both domestic and industrial liquid wastes, requires about six hours detention in the aerating tanks during which the bacteria can multiply, the suspended solids and colloidal matter can collect, and the nitrification can get well under way before these flocculated solids are deposited in the sedimentation tanks. To induce this action in the most efficient manner, it appears from experiments that the body of the liquor, while being agitated, should flow laterally from one end of the tank to the other. Thus the tanks are built long and narrow. Those in Milwaukee are 22 ft. in width and 472 ft. long by 15 ft. effective depth. With their peak load, it takes four hours to pass through, and eight hours at minimum load. Inasmuch as the same volume of air and sludge is being applied to the minimum load for eight hours as to the peak load of four hours, when the peak load arrives the sludge is of such bacterial richness that it is able to supply the maximum load with all the nitrifying agents required, and thus as good an effluent can be produced with the peak as with the minimum load.

TANKS SHAPED TO PRECIPITATE SLUDGE

One of the most complex problems involved is the precipitation of the activated sludge. This substance has an average specific gravity of only 1.005; it is fluffy and is readily broken up with very slight disturbance. Having been subjected to an abundance of air during the aerating operation, much air remains in the floc in bubbles of almost microscopic size, and is thus difficult to eliminate. It was found that the sludge would settle rapidly, about 1 in. per min., if undisturbed, but if carried for any considerable distance laterally through a tank, say, 15 feet or more, it would gradually rise in a parabolic curve to the surface and not again settle. If the velocity through the tank exceeded about $1^1/_2$ ft. per min., the lighter floc would not settle out but would remain suspended in the tank liquor for various periods until it finally reached the surface.

The depth of sludge allowed to accumulate in the tank had to be regulated because the nearer the sludge approached the surface the greater its tendency to pass out with the effluent, due of course to the lighter particles being on top and being influenced by surface currents and wind action. It is desirable to get as many suspended and settleable solids in the sludge as possible without fermentation as the denser it is, the greater the number of nitrifying organisms in it. To prevent fermentation, however, the sludge precipitated in the tanks must be constantly removed.



Sludge Concentrating and Collecting Tanks at Milwaukee

Tanks from 10 to 35 ft. deep were tried, either with steep sides in the form of inverted cones or with flat bottoms having mechanical devices to remove the sludge to a central discharge pipe. The circular flat-bottom tank was finally adopted and so designed as to have a maximum running-through velocity of $1^1/_2$ ft. per min. The apparatus included a mechanical collector consisting of arms revolving around a central shaft and supporting a series of plows, which pushed the sludge to a central discharge pipe; also a series of pipe arms containing branch pipes set to within an inch or less of the bottom of the tank. Through this system the sludge was drawn to the central discharge pipe by hydrostatic pressure due to the difference in elevation between the water in the tank and the sludge in the return sludge conduits. This type of precipitation tank has successfully operated for several years at a maximum rate of 1,600 gal. per day per sq. ft. of liquid tank surface, and with a maximum velocity through the tank of 1.5 ft. per min.

GRIT REMOVED AND SOLIDS SCREENED

At first it may appear that grit removal and screening are of little interest in the operation of the activated sludge process; but where the sewage to be treated is delivered by a combined system of sewers, or is a mixture of domestic and industrial wastes, these two items play an important part. With a purely domestic sewage they might perhaps be eliminated.

After long periods of experimental work, it was found that the heavy settleable solids carried in combined sewers sank to the surface of the air diffuser plates and decreased their efficiency. The larger suspended solids, such as fabrics, paper matches, seeds, hair, garbage, leather findings, and such materials, which accumulated in the aerating tanks, also settled to the bottom, stopping up the diffuser plates. There is in industrial sewage a fine line of demarcation between the settleable solids which may or may not be subject to rapid decomposition in any type of sewage treatment. If these solids were all grit from the scouring of streets or cleaning of industrial tanks, the problem would be easily solved; but unfortunately such is not the case, and all kinds of decomposable and undecomposable matters, of sufficient specific gravity to deposit in grit chambers, do reach the sewage works. For instance, soon after the plant was put in operation, an abundance of mash used by home-brewers reached the plant and settled in the grit chambers. To attempt to separate this from the grit was impracticable. Experiments conducted to determine the most efficient type of grit chambers proved that it was desirable there should be (1) as little disturbance in the passing-through liquor as possible; (2) a velocity of about 1 ft. per sec.; (3) a period of detention of about 90 sec.; and (4) a maximum depth of chamber of approximately 8 ft.

EXTENSIVE SCREEN TESTS NECESSARY

In determining upon fine screening, many types of screens were tested, both rotary and plate, the former being finally adopted. The problem was, however, to ascertain the size of particles permitted to reach the aeration tanks to prevent clogging of the diffuser plates and to get as much of the organic solids as was possible in order to add to the amount and value of the sludge. A $^3/_{32}$-in. opening on the screens was finally adopted and no difficulty has been experienced since operation. Many experiments have been conducted to determine the best methods of finally disposing of the screenings. Among these may be mentioned burying in trenches, pressing and burning under boilers and sludge dryers, and digestion. None has proven satisfactory to date; indications are that cremation will have to be resorted to.

DEWATERING OF SLUDGE

In conducting the experiments on the activated sludge process, it was early recognized that the Milwaukee conditions required the final and complete disposal of the sludge without raising objections from citizens or neighboring communities. Nowhere within reasonable distance, either within or without the city, was any land available upon which to deposit partially dried sewage sludge without causing an unbearable nuisance. While Lake Michigan was at our front doors, we had been advised by the Surgeon General of the United States against providing for depositing sewage sludge in the lake waters, no matter how far from shore the place of deposition might be. This sludge was like a yellow cur without a home.

It was also recognized that the complete dewatering of such a wet material was going to be extremely expensive and that, unless it could be disposed of in a fairly continuous market, the activated sludge process would prove too great a burden for the city to assume. In a broad study of the commercial disposition of sewage sludge, it was learned that in but one case, in Bradford, England, had it ever been a success, and that there was a distinct prejudice against its use as a fertilizer on the part of those to whom we must look for a market, the U. S. Agricultural Department and its agents, and the farmer. From this foreword, it will be realized that we entered into this field of investigation with great fear lest all of our hopes for a successful purification plant would be blasted by our failure to dispose of the sludge successfully. Therefore, from 1916, when we began to produce enough sludge for experimental purposes, up to 1925, when the large plant was put in operation, intense studies were made and great numbers of experiments were conducted; in fact, experiments are still being conducted to find some cheaper means of reducing the sludge to a fertilizer product.

MANY VARIANTS AFFECT DEWATERING

When the sludge leaves the sedimentation tanks, it contains from 98 to 99 per cent of water and has about the consistency of tomato bouillon. Its condition, as far as ease of dewatering is concerned, changes throughout the day, week, and season, influenced as it is by temperature, grease, industrial wastes, and peak and minimum loads. In order to overcome these several influences, it must be conditioned by some agent to reduce its alkalinity before the tension between water and solids can be partially removed. Many such agents, such as aluminum sulfate, ferrous sulfate, sulfuric acid, ferric chloride, and chlorine have been tried out, but the two most effectual and economical are sulfuric acid and ferric chloride.

A proper application and mixture of these agents before the sludge reaches the filters decreases the pH value in the sludge from about 7.4 to 3.0, which is the proper value to obtain good filtration. Three types of filter presses were tried out for several months; three types of centrifuges were operated, one as long as 18 months; two types of filters were experimented with for many months and the flotation method likewise for several months. It is perhaps unnecessary to add that thousands of tests were made upon the several kinds of dewatering apparatus under many different conditions, and with the full and free cooperation and assistance of the owners of the apparatus.

OLIVER FILTERS INTRODUCED

Feeling that we had exhausted the subject, so far as any information was available, we adopted the Oliver type of filter press and built 24 presses, each 11 ft. 6 in. in diameter and 14 ft. long. After these were put into operation great difficulty was experienced in securing proper filtration and several kinds of filtering cloths were tried. Finally canton flannel was found to give the best results, each cloth lasting about three months. These filters are reducing the moisture content in the sludge from 98 per cent to between 80 and 83 per cent, or its volume from 90 to 88 per cent, leaving from 10 to 12 per cent of the total volume of sludge to be further dewatered by drying.

SLUDGE DRYERS EFFECTIVE

In the experiments several types of dryers were tried out: rotary steam; belt steam; direct-indirect-steam and heat; direct heat; and indirect heat. Over three years were consumed in these experiments.

Finally it was decided to install the Atlas type of direct-indirect heat dryers, although the cost far exceeded any other type offered. When these dryers were put in continuous operation, the best production which they could give was six tons of dried sludge per day (24 hours). So we began to change the internal arrangements of the dryers, and to re-design the furnaces and methods of feeding until, after two years of this kind of development with our own forces, the dryers are now producing daily from 18 to 20 tons of dry material; that is, dried to contain 10 per cent of moisture or less.

The problem of conveying the filtered and dried sludge was a difficult one. Before designing the conveying system, the staff visited many plants where different types of conveying apparatus were installed. In addition, we erected some types in the experimental station. After erecting the system in accordance with the design made from the best available information, a considerable part proved to be quite unsatisfactory and had to be rearranged and improved.

After the sludge comes from the drier, it must be reduced by grinding to particles not more than $^{1}/_{8}$ in. in diameter, and not less than will pass a No. 80 screen. All dust must be eliminated to protect those men who subsequently handle the material. A few types of grinders and screens were tried until one type was finally adopted as the best. The dust was eliminated through a vacuum system connected to the apparatus.

DRIED SLUDGE DEMANDED FOR FERTILIZER

Early in the investigations activated sludge was found to contain a large percentage of ammoniacal nitrogen adaptable to fertilizing purposes, from 5 to 8 per cent, according to the period and intensity of aeration and the character of the raw sewage. In fact, this discovery largely influenced the Sewerage Commission finally to adopt the process as a means of reducing the cost of sewage treatment.

The problem of producing a commercial fertilizer and of being able to find a profitable market was to be solved. In view of the general prejudice against sewage sludge, already mentioned, this was not an easy task. We created a fellowship in the Agricultural College of the University of Wisconsin, and engaged E. J. Noer, a post-graduate of the college, as fellow. For two more years he made an intensive study of the value of the sludge in pot cultures, on the state farms, in hot houses, and on golf courses and lawns, until he proved beyond doubt that the organic nitrogen in the sludge was superior under many conditions to mineral or synthetic nitrogen. Then began a period of educating the Agricultural Department, and the Public Health Department of the Federal Government, county agents, and fertilizer manufacturers. The latter people were the most difficult, but as they were to be the largest customers special experiments and demonstrations were conducted for their benefit.

PLANT AND OPERATION COSTS

A few data concerning the cost of operating the Milwaukee plant, supplied through the courtesy of Robert Cramer, Chief Engineer, will shed light on this and other projects.

MILWAUKEE ACTIVATED SLUDGE PLANT

COST FOR YEAR ENDED DECEMBER 31, 1929

OPERATING DATA		
Average daily sewage flow		85 million gal.
Total annual sewage flow		31,025 million gal.
Dried sludge produced		34,124 tons
Dried sludge sold		31,602 tons
Contributing population (estimated)		600,000
COST OF SEWAGE DISPOSAL PLANT (Including testing and control station, excluding experimental and research expenses)		$9,078,782.13
SEWAGE PURIFICATION		
Operation and maintenance	$265,928.20	
General administration	7,979.47	
General engineering expense	2,744.47	
Gross cost of sewage purification		$276,652.14
SLUDGE DISPOSAL		
Operation and maintenance	$539,661.01	
General administration	15,898.55	
General engineering expense	5,599.93	
Selling and distribution expense	77,945.05	
Gross cost of sludge disposal		$639,104.54
Gross income from sludge disposal		686,587.44
Net profit from sludge disposal		$47,482.90
DISTRIBUTION OF 7 PER CENT ON COST OF PLANT (For interest and sinking fund)		
34 per cent chargeable to sewage purification	$216,075.00	
66 per cent chargeable to sludge disposal,	419,439.75	
Total interest and sinking fund charges		$635,514.75
COST, INCLUDING OVERHEAD		
Purification of sewage per million gallons	$15.88	
Disposal of sludge per million gallons sewage	11.99	
Total cost of service per million gallons sewage		$27.87
Purification of sewage per capita	$0.82	
Disposal of sludge per capita	0.62	
Total cost, including overhead, per capita		$1.44
COST, EXCLUDING OVERHEAD		
Purification of sewage per million gallons	$8.91	
Profit on sludge disposal per million gallons	1.53	
Total cost of service per million gallons		$7.38
Purification of sewage per capita	$0.46	
Profit on sludge disposal per capita	0.08	
Total cost of service per capita		$0.38

Overhead costs include interest on 20-year bonds at 5 per cent, plus 2 per cent sinking fund. All expenses for renewals, repairs, maintenance, and scrapping apparatus are included in operation and maintenance.

PROFITABLE SALE OF SLUDGE

Fortunately for our cause there had been no dependable supply of organic nitrogen since the Great War, and the packers, who had originally supplied this type of nitrogen for the fertilizers, had, during the War, turned their wastes into animal food, for which they obtained a more profitable price. Likewise the cotton-seed dealers had followed suit. Thus Milwaukee had a material to sell which the fertilizer manufacturers, after being convinced of its value, demanded to a greater extent than the city has been able to supply, so that the selling price has increased 50 per cent in four years, or from a yearly average of $14.09 to $21.78 per ton. This latter price about equals the total cost of sludge reduction, including 7$^1/_2$ per cent of capital cost.

Milwaukee sewage produces approximately 1$^1/_4$ tons of sludge of 10 per cent moisture per million gallons of sewage. This means that the plant is producing from 100 to 110 tons of dried sludge per day, and, when extended, will double this output.

MILWAUKEE PLANT BUILT DURING PRICE PEAK

In making a comparison between these figures and those of well-built and efficiently managed plants using trickling filters, the investigator must realize that the Milwaukee plant was built partly during and after the World War, when labor and materials were at their peak; that interest on bonds was at a high rate; and that the location of the plant was extremely expensive. The homes of 800 people had to be purchased and torn down, all structures had to be built upon pile foundation, land had to be recovered from Lake Michigan, and expensive bulkheads had to be built around the plant to protect it from the sea. These items alone exceeded one-half the total cost of the Baltimore plant.

The cost of pumping the low-level sewage is not included in these figures, because it is a charge against the sewage collecting system. The overhead charges are based upon 7 per cent of the capital costs. Securities for the construction are 20-year serial bonds yielding an average of 5 per cent. Repairs are included in operating charges.

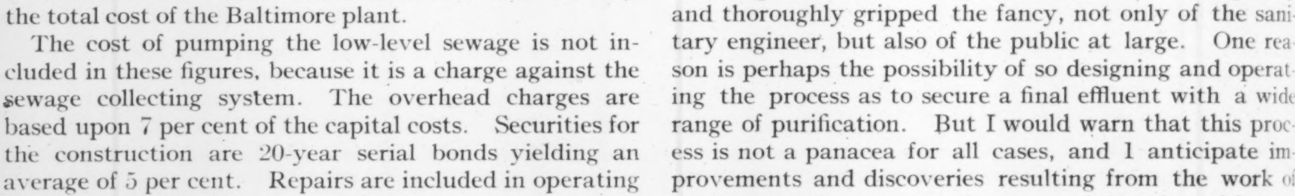
Great care has been exercised in presenting this financial statement because so many unverified ones have been made from time to time that false impressions have been general. A second purpose was to show that the cost of operating the process is not such a great burden upon the public as it would seem.

APPLICATION OF PROCESS

In determining upon the selection of the activated sludge process, the degree of purification required to meet local conditions must first be determined. If this be low, the process will not properly apply, owing to the cost of operation. If there is an opportunity to satisfactorily dispose of the sludge in a partially dried condition, a process which produces less sludge, in partially digested form, would probably prove more economical. If the community to be served is so small as to produce less than five tons of dried sludge per day, the building and operating of a complete sludge-drying plant might prove too heavy a burden; and if the community is too small to support a chemist or other technician for managing the operation of the plant, it would seem best to select a simpler process. The engineer who is competent to advise on the selection of the activated sludge process for any community should be familiar with the process as far as knowledge thereof is available, and also familiar with other leading processes both in this country and abroad.

CONCLUSIONS

Few processes of sewage treatment have so quickly and thoroughly gripped the fancy, not only of the sanitary engineer, but also of the public at large. One reason is perhaps the possibility of so designing and operating the process as to secure a final effluent with a wide range of purification. But I would warn that this process is not a panacea for all cases, and I anticipate improvements and discoveries resulting from the work of engineers and operators who are studying the subject.



Oliver Filters Dewatering Sludge at Milwaukee Activated Sludge Sewage-Disposal Plant

Arc Welding on Steel Buildings

Its Utilitarian Aspects

By Frank P. McKibben
Member American Society of Civil Engineers
Consulting Engineer, General Electric Company

WELDING of joints for steel structures offers so many possibilities of overcoming shop and field difficulties with riveted joints, and raises so many doubts in the mind of the conservative builder as to the safety of the results and the practicability of the method that this illuminating article by Professor McKibben cannot fail to interest the enthusiast, convince the doubter, and inform the engineer who has a general interest in the subject. This paper was presented before the Summer School for Engineering Teachers, of the Society for the Promotion of Engineering Education, Yale University, July 18, 1930.

WELDING may be classified according to the methods by which the joint is made and according to the type of joint. Gas welding is illustrated by the oxyacetylene, and chemical welding by the thermit process. The electrical methods comprise essentially resistance, arc, shielded arc, and atomic hydrogen welding. Each of these methods has an important field in which it is most useful. Welded joints are of two kinds: butt welded, where two parts, such as two plates, are placed edge to edge and welded along the joint, as shown in Fig. 1; and lap or fillet welded joints, where the plates overlap and a mass of weld metal is deposited along the edge of one plate and against the side of the other, as shown in Fig. 2.

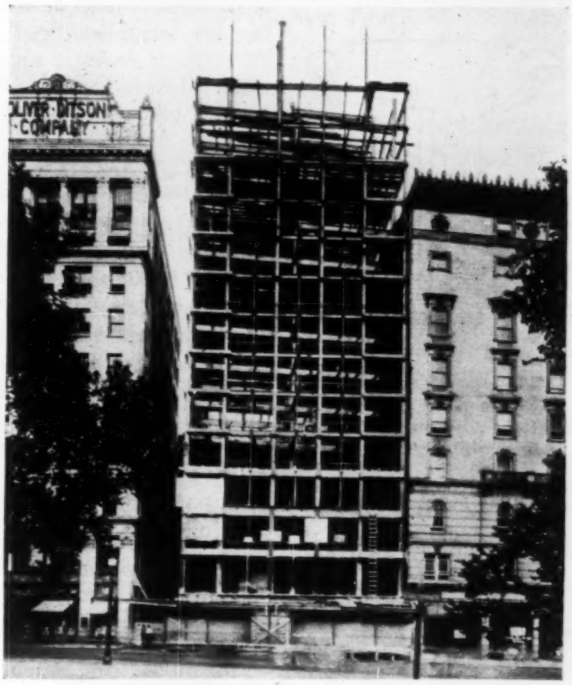
ELECTRIC ARC WELDING

Each kind of electric welding in the foregoing enumeration has its own particular field of usefulness. The arc weld is, however, the type which stands preeminent in welding steel building frames. In this process two pieces of steel, called the base or parent metals, are united by fusion caused by the intense heat of the arc. Diagrammatically, this is shown in Fig. 2, where plates *A* and *B* are welded with two fillets 8 in. long and of triangular cross section, the triangle having a base and altitude of $^3/_8$ in. each. The accepted designation for such a fillet is 8 in. by $^3/_8$ in. When welding plates $^1/_4$ in. or more in thickness, the electrode or welding wire is the negative side of the electric circuit, as shown in Fig. 2. The positive lead, or terminal of the circuit, is attached to any part of the base metals. The arc melts the two base metals as well as the electrode, and the latter must be replaced from time to time. The deposited metal should be, of course, cast steel with chemical and physical characteristics which have been determined with sufficient accuracy to be applicable in welded joints of ordinary size.

The electrode used in hand welding structural steel building frames is ordinarily about 14 in long and $^5/_{32}$ in., or $^3/_{16}$ in. in diameter with the following chemical properties: carbon, 0.13 to 0.18 per cent; manganese, 0.40 to 0.60 per cent; phosphorus, not over 0.04 per cent; sulfur not over 0.04 per cent; and silicon, not over 0.06 per cent. Wire used for electrodes is commercial mild steel wire, made for this purpose, of uniform homogeneous physical structure; free from irregularities in surface, from hardness, segregation, foreign matter, oxides, pipes, seams, or other defects.

Normal polarity, as used for electric circuits, places the electrode on the negative, and the base metals on the positive, pole of the circuit, as shown in Fig. 2. In this case the greater amount of heat occurs at the thick parts, the base metals, where it is needed to melt them and to secure good penetration. For welding very thin steels the poles are sometimes reversed from the condition shown in Fig. 2, and reversed polarity results.

The electrode is ordinarily used till the remaining stub end is about 2 in. long, when it is replaced. Recently compiled data based on one of the large office buildings welded in the field show that, on the average, 0.0429 lb. of wire was consumed and wasted per linear inch of fillet for all welding in the building. Most of the fillets were $^3/_8$ in.; a few were $^1/_2$ in. and $^5/_8$ in. Or, conversely, a pound of wire was required for every 23.27 in. of fillet. The electrodes used were $^5/_{32}$ in. and $^3/_{16}$ in. in diameter.



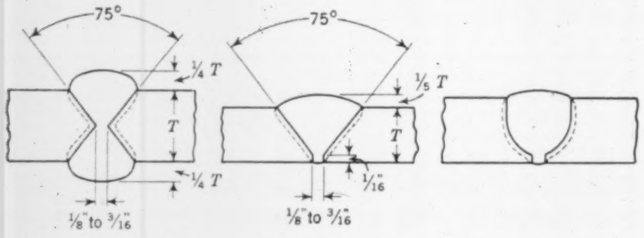
Field Welding an Aid in Noise Reduction
The Edison Electric Illuminating Company Building, Boston

STRENGTH OF THE CURRENT

Current may be either direct or alternating, but practically all welding on steel buildings is done with direct current. In welding the thin webs of light channels, the amount of current or amperage, that is, the heat, must be less than that used when welding thicker steels. Electrodes of small diameter require less heat than those with larger diameters. For depositing $^3/_8$-in. fillets by hand with $^5/_{32}$-in. electrodes, the ammeter on the welding machine should indicate approximately 150 to 200 amperes, while with $^3/_{16}$-in. electrodes the reading should be from 175 to 225 amperes.

HAND WELDING FITS FIELD CONDITIONS

Current values for machine welding may, and generally do exceed those given above. So far as I know, only hand welding has been used for the field welding of steel building frames and in ordinary connections in shop welding, but several shops have automatic welding machines that operate under heavy current and at great speeds, for welding plate girders, composite columns, or tanks.



DOUBLE V BUTT SINGLE V BUTT SINGLE U BUTT

FIG. 1

According to figures based on an eight-hour day and hand welding in the field on a multi-story building recently completed, a welder using $^5/_{32}$-in. or $^3/_{16}$-in. electrodes and approximately 175 to 200 amperes, deposited 50 in. of $^3/_8$-in. fillets per hr. in making column splices, connecting beams to beams, and beams to columns. This also amounted to 57 in. of fillet per ton of steel welded. Hand welding in the shop will show still higher speeds.

Arcs for structural steel welding should be of proper lengths to produce good results. A long arc gives a hissing sound interrupted by sharp explosive-like noises and accompanied by a scattering of globular metal particles about the fillet. A short arc, which should be used for welding low-carbon structural steel with low-carbon steel electrodes, as above specified, makes a crackling sound, deposits few or no globules or spatters, gives good penetration into base metals, and deposits a metal comparatively free from impurities. With $^3/_{16}$-in. electrodes, a current of 175 to 200 amperes, and an arc voltage of 20, the length of arc should be from $^1/_8$ in. to $^3/_{16}$ in.

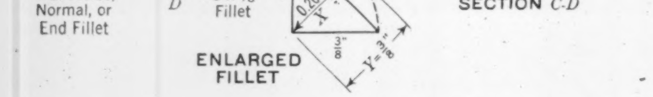


FIG. 2. LAP JOINT WITH SIDE FILLET IN LONGITUDINAL SHEAR
X Indicates a triangular fillet; and Y indicates a reinforced fillet

In welding steel buildings it is frequently convenient to set the welding machines (usually from two to four) in one place, either in the basement, on the first floor, or on the ground adjacent to the structure, and allow them to remain unmoved during the welding. As the steel frame progresses upward and longer lead wires become necessary, a slight drop in voltage may result. This is generally not noticeable in ordinary structures. When it occurs in tall buildings the current must be increased for the upper stories. In one building an increase of from about 175 to 185 amperes was found to be desirable.

PROTECTING WORKMEN AND BUILDING

To protect the operator's eyes and skin from the chemically active radiation of the arc, he should cover his face and neck with a helmet in which there is a dark glass to prevent the ultra-violet rays from injuring his eyes, but which permits him to see the arc clearly. Hands are generally protected by gloves.

So far as the steel building frame is concerned, there is no element of risk, even though it is a part of the electric circuit. But where timber forms, scaffolding, and floors are used in construction, falling sparks from the arc may cause fire by igniting some inflammable material, such as oily tarpaulin. The fire hazard from the arc is very slight, but it is as desirable to provide facilities for fighting fire when welding as it is necessary when riveting. In extreme cases it may be desirable to use asbestos or other fireproof material under the welder. However, I have not experienced any difficulty from this source.

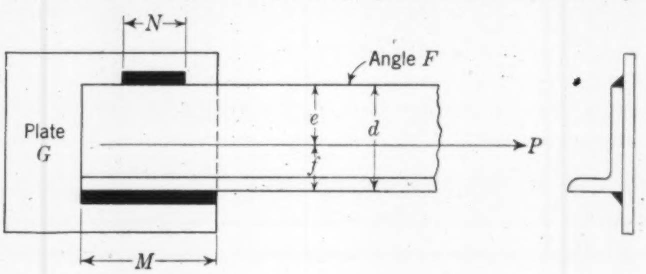


FIG. 3. LAP JOINT WITH LONGITUDINAL FILLETS CONNECTING ANGLE F TO PLATE G

BUILDING CODES PERMIT WELDING

Eighty-four towns and cities have by ordinance incorporated provisions for welding steel buildings in their building codes. In those cities where welding is permitted, though it is not explicitly so stated in the codes, permission rests on the discretionary power of the building commissioner, who is granted authority to allow the use of new methods or the new use of an old method if he is satisfied that such use is safe. For example, although Boston's building code makes no provision for welding, the commissioner granted a permit to field weld the 14-story office building of the Edison Electric Illuminating Company of Boston, using his discretionary powers under the following:

> "SYSTEMS NOT COVERED BY THIS ACT. If an applicant for a permit to build desires to use as a substitute for the materials or methods covered by this act . . . he shall present to the commissioner plans, formulas, and such other information, and shall make such tests or present satisfactory evidence of such tests, as the commissioner may require. . . ."

Specifications for the control of arc welding on steel buildings, based on experience, have been prepared by the writer. These have been followed on a sufficient number of buildings to establish their usefulness, and include the following headings: definitions, quality of materials, apparatus, permissible unit stresses, workmanship, qualification of welders, proportion of parts, and protection of steel.

CALCULATING STRENGTH OF FILLETS

In Fig. 2 the critical or minimum throat dimension for the $^3/_8$-in. triangular fillet shown at X is 0.266 in. If 11,300 lb. per sq. in. be allowed as the safe permissible strength of the fillet in longitudinal shear, a unit of $^3/_8$-in. fillet one inch long can transmit 11,300 × 0.266 = 3,000 lb. This establishes a permissible unit shear of 3,000 lb. per lin. in. for the $^3/_8$-in. fillet. As the triangular section is the one nearly always specified, this value of 3,000 is almost universally accepted for fillets of this size for quiescent loads. It therefore appears that in this case a safe unit shearing stress of 11,300 lb. per sq. in. is equivalent to 3,000 lb. per lin. in. To transmit a load of 48,000 lb. from plate B to plate A, the number of linear inches of fillet is 48,000 ÷ 3,000 = 16 in., or 8 in. on each side of plate B, in Fig. 2.

When the connecting piece, such as angle F in Fig. 3, is of unsymmetrical section, the two fillets may be of unequal lengths. If s is the safe allowable shearing strength of the fillet per linear inch, and M and N are the lengths of fillets required on back and toe of the angle, respectively, then by taking moments about fillet N the length of $M = \frac{Pe}{sd}$; and from moments at M the length of $N = \frac{Pf}{sd}$.

As the shearing strength of fillets is proportional to the throat distance, and therefore to the base of the triangle, Table I follows directly.

TABLE I. SAFE WORKING STRESSES OF TRIANGULAR FILLETS BASED ON 11,300 LB. PER SQ. IN. OF THROAT SECTION

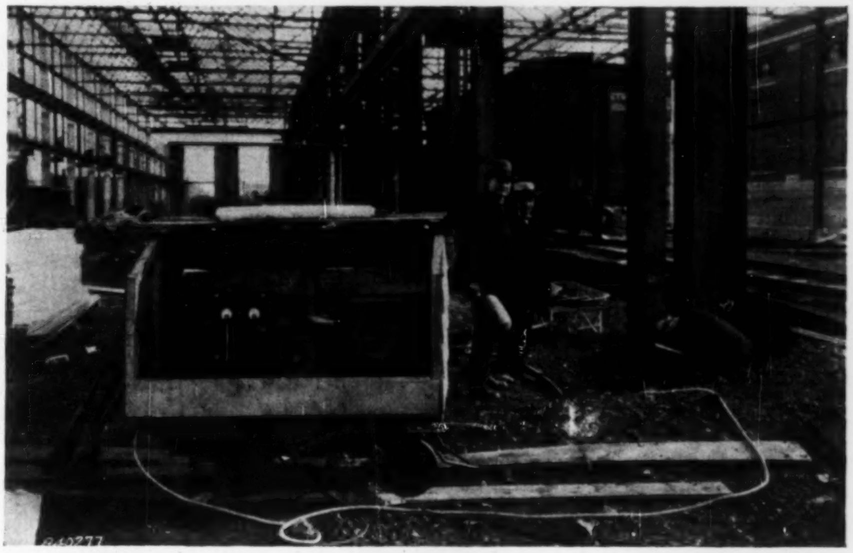
Size of Fillet, In.	Longitudinal Shearing Strength, Lb. per Lin. In.
$^1/_2$	4,000
$^7/_{16}$	3,500
$^3/_8$	3,000
$^5/_{16}$	2,500
$^1/_4$	2,000

It is evident from Fig. 2 that to increase the fillet from the triangle with a throat distance of 0.266 in. to the quarter circle Y, with throat of 0.375 in., would result in a corresponding increase in strength per linear inch, from 3,000 lb. to 3,838 lb. However, to secure this increased strength by reinforcing the fillet in this manner would probably cost much more than it is worth, except perhaps in vertical fillets where, due to the weight of the molten metal, a natural tendency toward assuming the reinforced form exists. However, in the present state of the art, it is well to use the 3,000 lb. per lin. in. for the $^3/_8$-in. fillet and not count on reinforcement.

WELDED PLATE GIRDER MOST ECONOMICAL

Welding in plate girders shows great savings in weight over riveting, but until a fabricator has acquired experience in welding he cannot expect to secure corresponding savings in cost. A welded girder is lighter than a corresponding riveted girder because:

1. For a given flange area the effective depth is larger in the welded type. Hence smaller flanges are possible to carry a given bending moment.



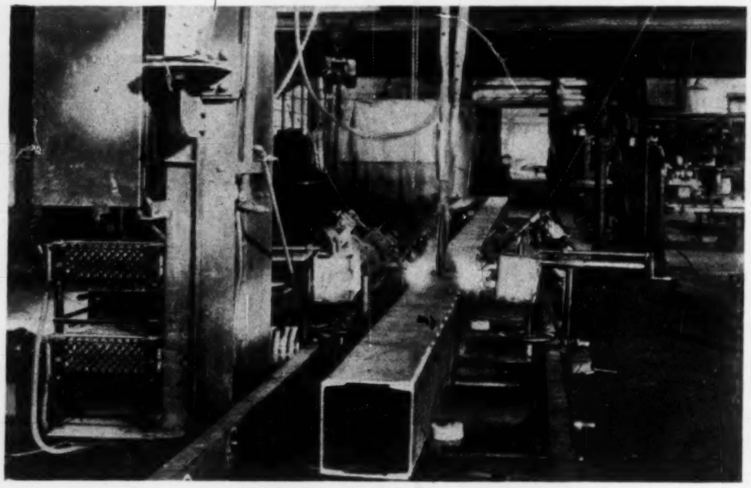
MOTOR-GENERATOR WELDING MACHINE FOR SINGLE OPERATOR

2. As no allowance for rivet holes need ordinarily be made in a welded tension flange, the flange area is less in the welded type.
3. In general no holes are necessary in the web of a welded girder at or near the point of maximum moment, consequently, the web equivalent may be taken as $^1/_6$ the gross web area instead of $^1/_8$, as where rivets are present. This increased web equivalent reduces the required flange area.
4. Web stiffeners on welded girders consist of flat plates, with one edge double-welded to the web and welded to the flanges. This eliminates the leg of the angle stiffener which lies against the web in a riveted girder and therefore reduces the weight of stiffeners.
5. Loose fillers are not necessary under web stiffeners of welded girders, although they are used in riveted girders unless the stiffeners are crimped.

The above list of five possible economies in welded girders is too impressive to be neglected. Nevertheless, riveted girders are still the standard in practically all shops because, with efficient riveting machines in use, the works manager hesitates to install automatic welding machines even though it appears that considerable metal may be saved by making the change. However, at least two companies, by introducing automatic welding machines into their shops, have set out to investigate the matter.

WELDING SAFE IN ERECTION

Small buildings of one story can be built without erection bolts, but for multi-storied structures bolts are necessary for safety. This is not because it is impossible to erect without bolts, but because the chances of accidents are too great. In arranging shop drawings it is well to allow for use of erection bolts near or in both the bottom and top flanges of the beams so that a certain amount of bending moment can be carried, which means that a certain degree of rigidity is secured. Preparatory to welding, erection bolts should be turned tightly to bring the steel parts as close together as possible. Wire cables may be necessary for tall buildings, to give added stiffness during erection and before welding is done.



Automatic Arc Welding Machine for Fabricating Box Columns or Plate Girders

It is surprising how few welders are necessary to field weld a building. At the West Philadelphia shop of the General Electric Company only two welders were used to connect the 987 tons of steel. At the Edison 14-story office building in Boston, four welders were used to field weld the 1,314 tons of steel in the building, of which 1,050 tons were actually connected by welding, the remainder being largely foundation steel.

QUALIFICATION OF WELDERS

In all important work the ability of welders must be established in some manner. If the welding contractor can prove his operators' efficiency by data from tests previously made, the operators should be qualified. If not, qualification tests should be given each welder. Such tests consist of welding three simple specimens:

1. *Lap welds.* Two plates each 6 in. by $^1/_2$ in. by 8 in. are clamped together with the 8-in. edges in line but with the 6-in. edges offset $^1/_2$ in., as shown in Fig. 4. A triangular $^1/_2$-in. fillet weld is then deposited along the offset 6-in. edges. After cooling, when the plates are broken apart, the weld metal should be bright, dense, even-textured, and crystalline or fibrous; and there should be good fusion of weld and base metals, and good penetration into the right angle corner of the fillet. This simple test eliminates the poorest welders.

2. *Butt welds.* Welders may next be required to weld a series of four butt joints, as in Fig. 4, prepared with a double V. The reinforcement on the weld is then ground off and the plate cut into specimens 2 in. wide and tested in tension. The average ultimate must be at least 45,000 lb. per sq. in. and the minimum not less than 40,000 lb. per sq. in.

3. *Fillet welds.* Finally, welders may be required to weld three sample test specimens with longitudinal fillets, Fig. 4, each fillet of $2^1/_2$-in. length including the crater, which in these specimens should be filled to the full triangular section in order to secure uniformity between the welders and to standardize the test. Average

TABLE II

TENSION TESTS ON BUTT WELDS TO QUALIFY WELDERS

Specimen	Area Sq. In.	Yield Point Lb.	Yield Point Lb. per Sq. In.	Tensile Strength Lb.	Tensile Strength Lb. per Sq. In.	Elongation % of 8 In.	Fracture
X-30-B 1	0.88	29,100	33,000	46,900	53,400	*	Outside of weld
X-30-B 1	0.87	29,600	34,000	43,800	50,400	25.0	Outside of weld
X-30-B 1	0.88	29,400	33,400	47,400	53,800	*	Outside of weld
X-30-B 1	0.88	29,700	33,700	47,700	54,200	25.4	Outside of weld
X-30-B 1	0.88	29,700	33,700	47,800	54,400	25.0	Outside of weld
X-30-B 2	0.88	29,000	32,900	48,000	54,600	*	Outside of weld
X-30-B 2	0.87	29,500	33,900	47,800	55,000	27.5	Outside of weld
X-30-B 2	0.87	29,500	33,900	47,700	54,800	17.5	At weld
X-30-B 2	0.90	29,700	33,000	49,100	54,600	27.5	Outside of weld
X-30-B 2	0.86	29,100	33,800	47,900	55,700	26.7	Outside of weld
Y-31-B 1	0.94	32,000	34,000	51,200	54,500	13.1	At weld
Y-31-B 1	0.94	32,100	34,200	51,800	55,000	12.9	At weld
Y-31-B 1	0.98	33,000	33,700	53,000	54,000	15.1	At weld
Y-31-B 1	0.98	33,200	33,800	53,500	54,600	19.5	At weld
Y-31-B 1	0.98	32,700	33,400	52,800	53,800	*	Outside of weld
Y-31-B 2	0.98	33,300	34,000	49,700	50,600	8.75	At weld
Y-31-B 2	0.97	32,500	33,500	49,700	51,200	9.5	At weld
Y-31-B 2	0.97	32,100	33,100	50,600	52,200	13.1	At weld
Y-31-B 2	1.00	33,200	33,200	53,400	53,400	15.6	At weld
Y-31-B 2	0.99	33,100	33,400	48,500	49,000	8.0	At weld
Z-32-B 1	0.88	30,400	34,500	46,300	52,600	10.9	At weld
Z-32-B 1	0.89	30,300	34,000	49,100	55,200	27.5	Outside of weld
Z-32-B 1	0.89	30,500	34,300	47,000	52,800	11.6	At weld
Z-32-B 1	0.86	28,500	33,200	43,500	50,600	8.5	At weld
Z-32-B 1	0.85	29,500	34,700	44,300	52,000	16.6	At weld
Z-32-B 2	0.88	29,500	33,500	46,400	52,800	12.5	At weld
Z-32-B 2	0.88	28,800	32,800	44,200	50,200	9.37	At weld
Z-32-B 2	0.90	30,400	33,800	45,700	50,800	10.5	At weld
Z-32-B 2	0.87	29,000	33,300	45,800	52,700	10.6	At weld
Z-32-B 2	0.89	29,400	33,000	47,500	53,400	26.4	Outside of weld

* Broke outside of weld, but at or very near one-gage mark.

ultimate longitudinal strength of the three specimens should be at least 44,000 lb. per sq. in., and the lowest in the group should show at least 38,000 lb. per sq. in. of minimum section of fillet.

Table II presents a series of tension tests on butt-welded mild steel specimens 2 in. wide and approximately ½ in. thick, made as shown in Fig. 4, with the weld reinforcement ground off before testing. For each of the three welders, X, Y, and Z, ten tests were made, specimens B1 being welded with the weld horizontal, and B2 vertical. It is observed that the lowest value is 49,000 lb. per sq. in. and the highest 55,700. All three of these men were accepted.

TABLE III. TESTS ON $^{3}/_{8}$-IN. FILLET WELDS TO DETERMINE THEIR LONGITUDINAL SHEARING VALUES AS MEASURES OF THE WELDER'S ABILITY

Mark	Yield Point Lb.	Maximum Load Lb.	Maximum Load per Lin. In.
X-30-F 1	117,000	149,000	14,900
X-30-F 2	116,000	154,300	15,430
Y-31-F 1	119,000	133,600	13,360
Y-31-F 2	117,500	133,100	13,310
Z-32-F 1	115,500	140,500	14,050
Z-32-F 2	114,900	155,200	15,520
	Average	144,283	14,428

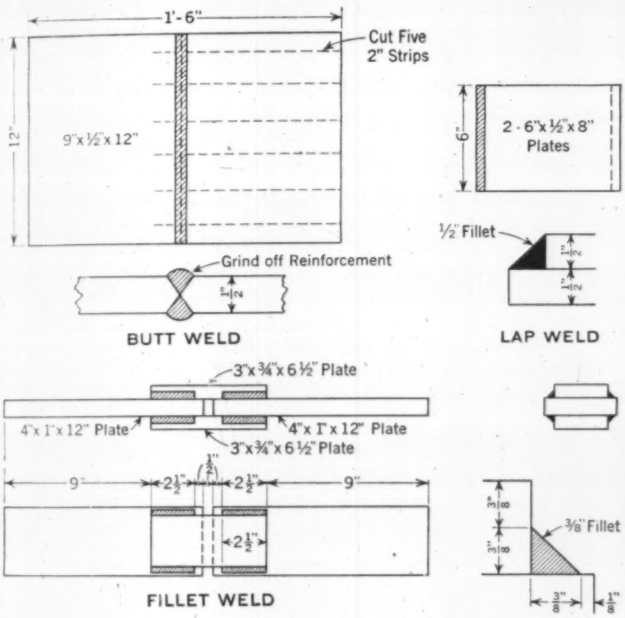
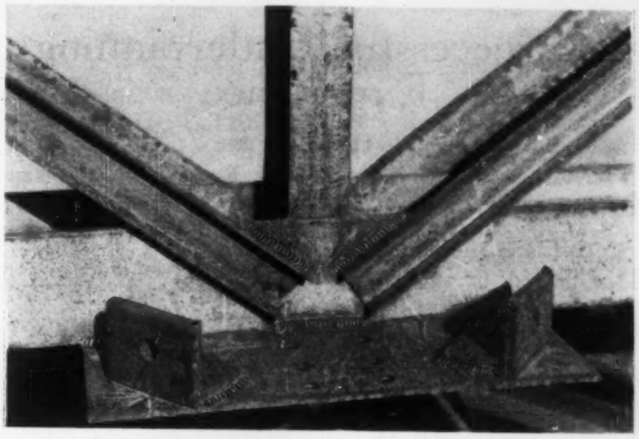


Fig. 4. Specimens for Qualifying Welders

Table III sets forth a few typical qualification tests on fillet welds, as depicted in Fig. 4, to determine the competency of the three welders, X, Y, and Z, to work on a tall building. The ultimate longitudinal shearing value is a measure of the operator's ability to weld. The lowest of the six tests is 133,100 lb. ultimate; the highest, 155,200 lb.; and the average, 144,283 lb. As the fillets on each side of the center line or splice aggregate 10 lin. in., the average ultimate longitudinal shearing strength of the $^{3}/_{8}$-in. fillets is 14,428 lb. per lin. in. Inasmuch as we allow a working stress of 3,000 lb. per lin. in. for fillets of this size, the foregoing average represents a factor of safety of 14,428 ÷ 3,000 = 4.8. Again, since the shearing stress is 14,428 lb. per lin. in., this corresponds to an ultimate unit shearing stress of 14,428 ÷ 0.266 = 54,240 lb. per sq. in. And as we allow 11,300 lb. per sq. in. working stress on the throat or minimum section, this corresponds to a factor of safety of 54,240 ÷ 11,300 = 4.8, which, of course, agrees with the above.

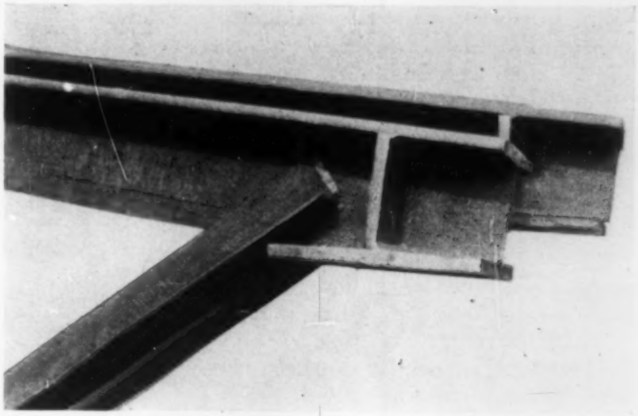
PROCESS DECIDEDLY ADVANTAGEOUS

Interest in arc welding for steel buildings is great and is extending rapidly. As the process has certain decided advantages, it should be the aim of structural engineers to guide its growth in safe channels, to use it when desirable, and to exclude it when not. When, in 1927, the writer was connected with the welded factory building of the General Electric Company at West Philadelphia, he little realized that in 1930 he would be engaged in welding two 14-story buildings and one of 19 stories.



Central Lower Chord Joint of Arc Welded Truss

There is no doubt that the greatest advantage which welding now shows is in the elimination of noise. Some recent bids indicate that the cost of welding ordinary buildings is no greater than that for other forms of fabrication and in some types of construction a distinct saving is secured. The first welding contract a shop has may prove more costly, however, and the works manager should not reach a decision prematurely. Judging from the manner in which the use of welding is increasing, the process seems to offer possibilities in cost reduction. The freedom from failures which has thus far accompanied the rapid growth of the art is remarkable.



End Upper Chord Joint of Arc Welded Roof Truss Showing Bearing at Column Cap

HINTS THAT HELP

Today's Expedient—Tomorrow's Rule

The minutiae of every-day experience comprise a store of knowledge upon which we depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from young and old alike, should afford general pleasure not unmixed with profit.

A Successful Underpinning Experience

By Henry Wise

Junior, American Society of Civil Engineers, Engineering Assistant, Board of Transportation, New York

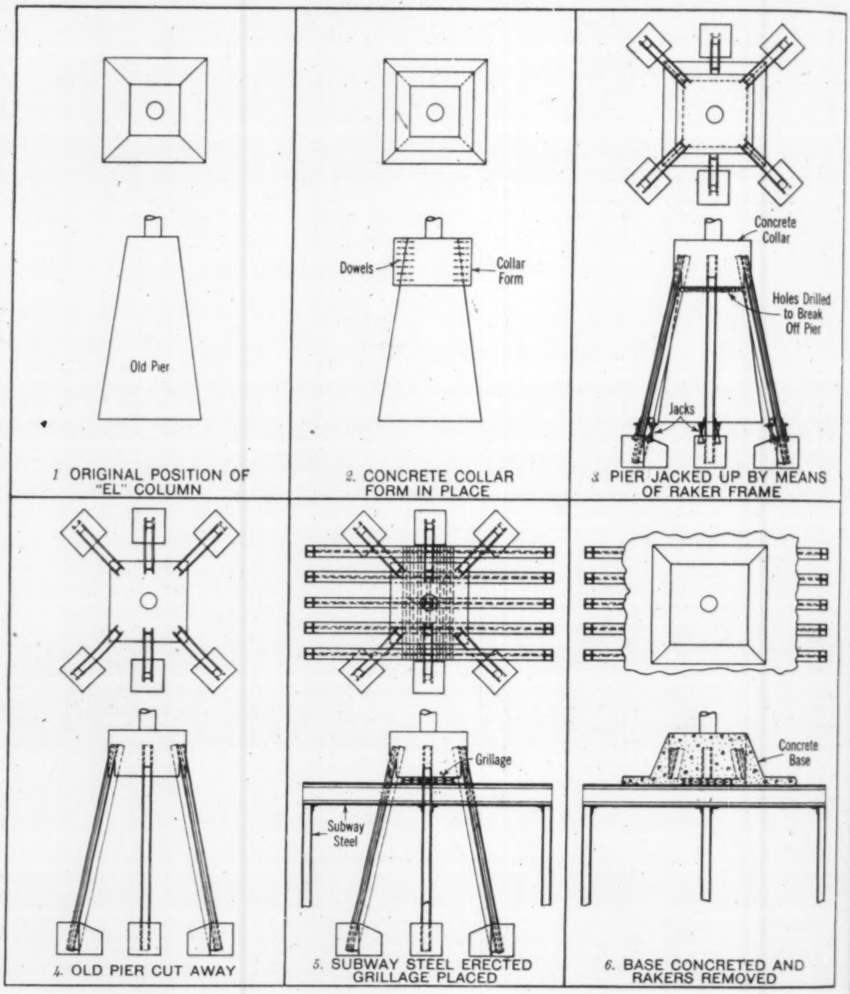
Unless they are already experienced in subway construction or foundation work, engineers will probably be interested in methods for the removal of old, and the construction of new foundations without disturbing the supported structures. In this article, an attempt is made not only to indicate the prevailing method, but also to describe a successful experiment in a raker-beam type of underpinning that is believed to be absolutely new in the engineering world.

In the process of constructing the new Nassau Street subway loop in New York City, many complications made the work of excavation and of underpinning difficult. Among the greatest obstacles were the old concrete and brick piers supporting the overhead rapid transit line structure, of the old "El," adjoining Brooklyn Bridge. One of these piers upheld a load of over 150 tons, an immense weight involving a number of unforeseen difficulties.

ORDINARY JACKING METHOD IMPOSSIBLE

An obvious method of underpinning such piers is that of first drilling holes through the center, inserting I-beams, concreting them solidly in place, and then jacking up on the extended ends. After the load is taken on the jacks, through the inserted I-beams, the old pier is cut off and cleared out of the way so that the new subway structure can be erected. Upon the completion of the new subway, a concrete pier is built from the subway roof to the base of the supported pier, the jacks are removed, and thus the load is shifted to the new subway. But this could not be done here because the immense load to be carried necessitated close column spacing in the new subway wall under the pier, so close that it would not leave space for the manipulation of the jacks. In this case it was necessary to devise an underpinning which would not interfere with the new construction, following the method illustrated in the accompanying series of sketches.

A concrete collar, 10 ft. square and 6 ft. deep, was built around the old pier, just above the proposed elevation of the new subway roof. Into this collar the upper ends of six long, heavy I-beam posts, inclined outward, were concreted. One was placed at each corner, and the other two were at the centers of opposite sides. These I-beams formed a frustrum of a rectangular pyramid, and were rigidly bolted and framed together by cross-bracing. The bottoms were supported on small independent concrete foundations, about 7 ft. deep and 5 ft. square, the faces being normal to the bases of the I-beam posts.



1 ORIGINAL POSITION OF "EL" COLUMN

2. CONCRETE COLLAR FORM IN PLACE

3. PIER JACKED UP BY MEANS OF RAKER FRAME

4. OLD PIER CUT AWAY

5. SUBWAY STEEL ERECTED GRILLAGE PLACED

6. BASE CONCRETED AND RAKERS REMOVED

Sequence of Underpinning Operations for Load Transfer

RAISING THE ELEVATED

Two jacks were placed under each post, the jacks bearing on angles riveted to the flanges of the beams, at a distance from the base slightly greater than the height of the jacks. In this way the jacks could be inserted and do their work; then wedges could be driven under the base of the beams to hold any rise, and the jacks taken out for use elsewhere. After the concrete was set, an initial pressure of 500 lb. per sq. in. was put on the jacks to take up any play or strain, and to test the foundations for settlement. All the jacks were interconnected by pressure piping to insure equal bearing.

Upon the completion of all preparations and the assembling of visiting engineers, including a group from the American Society of Civil Engineers, the workmen began to apply pressure. By a system of bells to be rung from the street, where the levelman was watching the movement, the foreman was notified when the column had risen $^1/_4$ in. At a pressure of about 3,000 lb. per sq. in., this rise was accomplished, lifting not only the El load of 150 tons, but also the weight of the pier below, about 60 tons more. Previous to the raising, holes had been drilled into the pier just below the collar, and by driving plugs into feathers placed in the holes, the lower part of the pier was cracked off, dropping back nearly the $^1/_4$ in. that it had been raised. The amount of drop was unimportant; all that was needed was to allow the lower part of the pier to be free for subsequent removal and the upper part to be safe against settlement. This new type of underpinning gave both. The old and now useless lower section was quickly removed, leaving the collar with its load of 150 tons, standing up in the air on six slender steel legs. The new subway was then constructed, grillage was placed under the collar, and all was concreted. Lastly, the six I-beam posts were burned off, as the load had been transferred to the new subway roof. The El suffered no loss of time, or tie-ups for fear of an unsafe condition.

EXPERIMENT PROVED SUCCESSFUL

Is this not an instance of the engineer's resourcefulness in analyzing existing conditions and discovering methods of combating them? When the old type of underpinning could not be used, a new one was found to fit the conditions. The principle of building a temporary base, underpinning it, cutting away the old foundation and building a new, and finally placing the load on the new structure, was used in this case; but the ingenuity in the design of the temporary underpinning to keep it out of the way of construction, and the success of its application reflect special credit on the designers and consulting engineers, Spencer, White, and Prentis, Inc. Not only did the structure hold its load, but highly accurate settlement levels, taken every second day until the collar had been concreted on the permanent subway steel, never revealed a difference greater than 0.005 ft. from the original elevation reached the day the column was raised.

Others, besides the designers, who deserve credit for the success of the experiment are Donald C. Waite, M. Am. Soc. C.E., and William F. Fox, M. Am. Soc. C.E., engineers from the Interborough Company, who were responsible for the company's structure; and Herbert M. Hale, M. Am. Soc. C.E., of the Marcus Contracting Company, the builders of the new subway.

Summer School for Engineering Teachers

Society for the Promotion of Engineering Education, Yale University, New Haven, Connecticut, July 1–23, 1930

Fully two-thirds of those present at this meeting are members of the Society and an even greater proportion of the papers were presented by members of the Society

Our Readers Say—

Is City-Suburban Transit System Needed?

DEAR SIR: Engineers seem to be pretty well agreed that the type of suburban transit system outlined in Mr. Stuart's paper would serve the New York region efficiently, but there seems to be some difference of opinion as to the need for such a system. The idea has been expressed that the construction of new distributing lines in the central area is not now justified, on the assumption that existing transit lines can continue to carry the commuter load. We should answer not only the question "Can they carry this load," but also the question "Even if they can, should they?".

New York is years behind in its rapid transit construction and is making a valiant effort to catch up. The lines now under construction and those proposed by the Board of Transportation are certainly not more, and are probably somewhat less, than those required to relieve existing congestion and to take care of traffic increases if all are placed in operation by 1940. That the present congestion has exceeded the bounds of decency is generally admitted.

I believe that it is wrong to approach the question of justification of a separate suburban transit system from the point of view of whether or not we can get along without it. We could get along without the radio and probably even without the telephone; we could live on concentrated food pills, but why should we? The proper procedure is to find out whether or not we can *afford* a separate suburban system—that is, whether or not there will be traffic enough to justify it and enable it to pay expenses.

The approach to this is through a consideration of a reasonable density of traffic per track mile and an estimate of what the traffic demands will be. On the New York City rapid transit lines the number of passengers per track mile per year increased from about 1,200,000 in 1900 to a little over 3,000,000 in 1925. A traffic density of from 1,500,000 to 2,000,000 would be a reasonable density to assume for a suburban rapid transit system.

Let us assume the existence of a suburban transit system, totaling about 30 route miles, consisting of a New Jersey–Manhattan loop and connections to Long Island and Westchester County. On a conservative basis, the 1924 traffic counts on such a line, had it been in existence at that time, would have been about 118,000,000 passengers, representing a track-mile density, on a two-track system, of 1,950,000 and indicating that such a system would have been justified in 1924. Making the same assumptions for 1935, and using the traffic estimates made by the Regional Plan, we find that the traffic density on a two-track system would be about 3,000,000 passengers, and on a four-track system about 1,500,000 passengers. This would indicate that, even on this conservative basis, a two-track system would be insufficient in 1935 and that a four-track system would be justified if congestion is to be avoided and some allowance made for expansion.

The advantages of a separate suburban system can be summed up as follows:

1. Relief of congestion at existing trunk-line terminals, providing room for the normal expansion of long-haul traffic.
2. Release for shipping purposes of New Jersey waterfronts now occupied by railroad passenger terminals.
3. Faster and more comfortable travel for the commuter nearer his New York City destination.
4. Increased capacity for local riders on New York City rapid transit lines.

H. M. LEWIS, M. Am. Soc. C.E.
Executive Engineer, Regional Plan of New York and Its Environs

New York, N.Y.
August 29, 1930

Existing Subway Facilities Sufficient

TO THE EDITOR: In commenting on Mr. Stuart's admirable paper, I wish it understood that the views expressed herein are entirely personal, and that they are in no way the studied conclusions of the New York, New Haven, and Hartford Railroad.

The problem of handling suburban traffic into and out of New York is huge, but when it is resolved into percentages it becomes a small problem compared with the handling of local transit within the city. The number of suburban passengers using New York transit lines in gaining access to their final destinations within the city constitute less than 6 per cent of all the passengers handled on the city transit lines. I am unable to believe that any separate, distinct rapid transit suburban system 70 to 100 ft. deep in Manhattan is necessary to distribute that 6 per cent when there is already a system functioning today which can handle them at less cost than could a separate transit system.

Special studies of commuters from Westchester show that approximately one-half of them are destined to buildings in the Grand Central Zone. They do not want to be brought down to some point in another subway at an additional fare of 15, 20, or 25 cents. The facilities of the Grand Central Terminal are greater than now needed, and ultimately more tracks can be provided between Mott Haven and Grand Central. The New Haven now provides 100 seats per 70 passengers and its trains can be lengthened. The New York Central expects soon to increase the train capacity of the four-track line into Grand Central Terminal by 25 per cent. These facts show possibilities for keeping pace with the growth of Westchester County suburban traffic.

An additional surprising fact is that the existing subways below 57th Street are not now used to capacity. Of twelve rapid transit tracks south of 57th Street only two express tracks are used to suffocation during the rush hours; the local tracks are not working anywhere near their full capacity. The Brooklyn-Manhattan Transit tracks under Seventh Avenue and Broadway are not used to anywhere near their capacity. The congestion on the two express tracks can be relieved by equalizing the load among the six southbound tracks in the morning, and the six northbound tracks in the evening.

The New Jersey problem differs very materially from the Long Island and Westchester problems. The Jersey roads have the problem of getting their passengers across the river into New York City. About one-half these passengers must use other transit facilities after arrival there. There will be found in New York subways available capacity for Jersey commuters. The New Jersey problem is to get the passengers to the New York subways. The Hudson and Manhattan Railroad has built up a sphere of influence around 33rd Street and Sixth Avenue and around the Hudson Terminal downtown, in which commuters using its lines do not require further transit facilities.

The North Jersey Transit Commission has presented an attractive plan for increasing the commuting facilities from Jersey by proposing two lines, one of which might be the Hudson and Manhattan's Sixth Avenue line extended north and thence across the Hudson again and another line under the Hudson twice and up the east side of Manhattan. With two such lines as that the situation would be greatly simplified.

C. E. Smith, M. Am. Soc. C.E.
Vice President, New York, New Haven, and Hartford Railroad

New Haven, Conn.
September 4, 1930

Gas Rafts and Sludge Settlement

Sir: In reading Mr. Hatton's paper on activated sludge, I was again impressed with the fact that difficulties encountered in the settling of activated sludge are extremely aggravating and troublesome, and information on the underlying causes and principles responsible for inadequate sludge precipitation is sorely needed. If the sludge particles follow the laws which apparently hold for sedimentation of sewage solids, it would be anticipated that a precipitating particle would continue its downward path as it flowed along through a sedimentation tank. Mr. Hatton's observation that the activated sludge particle does not follow this course, but, on the contrary, after a preliminary downward movement, follows a parabolic path to the surface, is therefore of extreme interest. What are the factors that are responsible for this phenomenon? If it is due merely to entrained air, as is intimated, then gentle agitation with an opportunity for the escape of this agent should be effective in causing the sludge to settle eventually.

Is it possible that, as the sludge progresses along its path, the oxygen in the entrained air is used by biological growth, and that in the course of the resulting removal of oxygen, the nitrogen equilibrium in the air particle is so disturbed that the nitrogen bubbles from nearby particles combine to form larger gas bubbles, which act as rafts or create vertical currents on which the very small sludge particles are carried?

This phenomenon of the rising of activated sludge is not restricted to continuous-flow sedimentation tanks but has been observed also in quiescent settling tanks. In some studies on activated sludge from packing house waste, the sludge was observed to settle very readily in liter graduates in the course of 15 to 30 min., forming a very compact mass at the bottom; but within a few minutes thereafter from 30 to 100 per cent of the sludge would rise en masse to the surface. Agitation of this surface sludge invariably resulted in its rapid resettling, only to rise again on continued storage. It is felt that this was due to active fermentation resulting in production of gas particles beyond the solubility coefficient in the liquid, so that the particles coalesced to form a gas raft upon which the sludge, with its very low specific gravity, rose. It should be borne in mind, however, that this sludge, although of good physical appearance, was not a strong nitrifying agent. The point is that the rising of sludge might be due to entrained air, but it is also conceivably due to production of gases by biological action beyond the saturation point at the point of production.

The limitations of the activated sludge process are well stated by the author in his conclusions. His observations along this line are heartily concurred in. In the experiments with creamery waste at the Iowa State College, it was clearly demonstrated that an activated sludge of a very high purifying power could be produced, but it was also observed that, unless the waste applied could be maintained at a reasonably constant concentration and volume, the process was quite erratic as regards the maintenance of a suitable activated sludge. Another interesting observation in this connection was that, although the sludge was of good physical appearance, very objectionable odors were produced during early stages of treatment. With the same waste treated on trickling filters such odors were not observed. The proper recognition of its limitations should aid in promoting the activated sludge process by avoiding the mistake of employing it under conditions which are unsuitable to its success.

W. E. Galligan, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering, Iowa State College

Ames, Iowa
September 8, 1930

Activated Sludge Process Makes Progress

Sir: Mr. Hatton's historical review puts the writer in mind of his student days when he was absorbing the rudiments of sanitary engineering from the late George C. Whipple, M. Am. Soc. C.E. The activated sludge process at that time made its appearance like a new star upon the firmament. Our elders were by no means certain of its classification, and while they were willing to state that the new star might have its place among the fixed stars, they were by no means certain that this was the case. To many of Professor Whipple's students, however, the discovery or, as we later learned, the rediscovery of the activated sludge process, reported to us by Professor Bartow on his return from Manchester, England, was an inspiring assurance that sewage treatment was not a cut-and-dried subject, but a field of knowledge still capable of fruitful tillage by new and unsuspected methods.

Engineers will be glad to note the continuing interest in research manifested by those in charge of the Milwaukee plant, as the possibilities of the activated sludge process, in the writer's opinion, are by no means exhausted. Experimental evidence is accumulating both in this country and abroad, which shows that we may look forward to modifications and refinements, and perhaps a complete realignment of the process that will extend its usefulness and improve its economy. No longer do we think of the activated sludge process as necessarily complete in itself. Activation is being employed both as a preparatory process, preceding trickling filters, for example, and as a key process, following sedimentation or contact aeration. Values are being recovered from the sewage treated by this process not only in the form of fertilizing sludge, but also as gases of digestion whose energy is readily utilized. Finally, subdivision of the process into its natural steps seems to give promise of new and possibly far-reaching developments.

Gordon M. Fair, M. Am. Soc. C.E.
Associate Professor of Sanitary Engineering, Harvard University

Cambridge, Mass.
September 11, 1930

SOCIETY AFFAIRS

Official and Semi-Official

The Society's Publication Policy

CIVIL ENGINEERING is needed to amplify the service to members.

It is to present some of the Society's technical papers in a form which shall be attractive to a large proportion of the members, thus effecting wider dissemination of knowledge of engineering progress.

It is to provide a suitable outlet for material dealing with professional activities, as a means of making the Society a more dynamic force in the non-technical and professional relations of the engineer.

It is to furnish improved facilities for the officers and committees of the Technical Divisions, to inspire and maintain the interest of their members in Division work; and for Society committees in the duties and problems assigned to them.

It will be a medium through which manufacturers can describe their products to buyers, and thereby keep members informed of progress in engineering materials and equipment.

TRANSACTIONS, as heretofore, will be the reference volume and will contain all papers from PROCEEDINGS with their discussions, and memoirs.

PROCEEDINGS will be continued and will contain the more highly technical and the longer papers of especial value for studious concentration.

MANUALS on special topics, in addition to these regular publications, will be issued as material shall become available and, occasionally, there will be other separate publications of particularly voluminous and noteworthy papers or reports.

CIVIL ENGINEERING is to be a vigorous presentation of new ideas in the field of civil engineering. The main body of its text will be articles, descriptive of engineering data, analyses, theories, and practice. Primary emphasis will be placed on basic principles rather than record of accomplishment; on how design or construction has been advanced over previous practice, that is, on underlying factors accounting for progress in the art.

It will also serve advertisers who find in its readers an audience they desire to address. A charge will be made for this use commensurate with its value. The income that shall be derived from such advertisements will aid in promoting the objects for which the Society has labored for nearly eighty years, "... the advancement of the sciences of engineering and architecture in their several branches."

CIVIL ENGINEERING will contain some new columns or departments. In it will be found the doings of the Society's Local Sections, Student Chapters, Employment Service, and the Library. It will be the official exponent of Society activities.

PUBLICATIONS COMMITTEE,

HARRISON P. EDDY, *Chairman* MALCOLM PIRNIE
MORRIS KNOWLES OLE SINGSTAD
CHARLES H. STEVENS

September 9, 1930

Secretary's Abstract of Executive Committee Meeting

AT 10:45 on the morning of August 11, 1930, the Executive Committee met at Society Headquarters. President Coleman was in the Chair; Secretary Seabury, Treasurer Hovey, and Messrs. Bush, Dougherty, and Winsor were present. Mr. Charles A. Baker, of Society's counsel, attended by invitation.

Approval of Minutes

On motion, the minutes of the last meeting held on April 21, 1930, were approved as adopted by the Board.

Redistricting and the Appointment of an Additional Director

A business meeting of the Society was fixed for October 1, 1930 in St. Louis at the time of the Fall Meeting, to carry out the necessary legal procedure to confirm the action changing the number of members of the Board of Direction.

George Washington Bicentennial Commission

The following resolution, endorsing the program of observance of the two hundredth anniversary of the birth of George Washington, was adopted:

> *Whereas,* The Congress of the United States has created a commission to arrange a fitting nation-wide observance of the two hundredth anniversary of the birth of George Washington in 1932, and
>
> *Whereas,* The commission has invited the American Society of Civil Engineers to endorse the program of the commission, therefore be it
>
> *Resolved,* That the American Society of Civil Engineers does hereby heartily endorse the program of the U.S. Commission in its work of planning and directing the celebration.

Joint Committee of Engineers and Architects

The Secretary was authorized to address a letter to the President of the American Institute of Architects suggesting the appointment of four architects to meet with a similar group of engineers for the purpose of arriving at an agreement whereby a nation-wide program of cooperation between architects and engineers might be brought about.

Fall Meeting at St. Louis

As CIVIL ENGINEERING goes to press, the fall meeting of the Society is about to be called to order at the Jefferson Hotel in St. Louis. The sessions will commence on October 1 and will continue through Saturday, October 4. The detailed program, copies of which have been received by members, shows the customary business meetings and, in addition, sessions of a technical meeting and of the Construction, Highway, and Waterways Divisions, at which technical papers will be read. After the dinner on Wednesday, October 1, C. E. Grunsky, Past-President Am. Soc. C.E., and Dr. G. W. Dyer, Professor of Economics at Vanderbilt University, will deliver addresses. The dinner and addresses will be followed by dancing.

Entertainment features for the ladies include a luncheon and an afternoon of cards on Wednesday, October 1, at the St. Louis Country Club; a morning's shopping tour and individual hospitality on Thursday; and, on Friday and Saturday, participation in the general inspection trips. Entertainment for all will be provided on Thursday evening, October 2, in the form of a "Home Folks" evening of cards, games, dancing, and other informal amusements.

Tours and inspection trips about St. Louis will occur on Thursday and Friday afternoons, October 2 and 3, and the local committee will arrange such special tours as are desired, providing transportation and securing such permits as are necessary and obtainable. A very remarkable tour has been arranged for Saturday, October 4. Registered members and ladies of their families will be guests of the Missouri Pacific Railroad on an all-day tour through the Near Ozarks, to the hydro-electric dam at Bagnell, Mo., about 170 miles from St. Louis. The party will leave St. Louis at 7:30 A.M. on a special train. The ladies of the party, who so desire, will be guests of Mrs. Henry S. Caulfield for luncheon at the Governor's Mansion in Jefferson City. The train will leave Bagnell at 6:00 P.M., arriving in St. Louis at 10:30 P.M., completing what promises to be a most unusual and interesting inspection trip.

Two meetings of the Society have previously been held in St. Louis, the Twelfth Annual Convention, 50 years ago, in 1880, and the Thirty-sixth Annual Convention, 26 years ago, in 1904. The meeting in 1904 was held during the World's Fair, and the Society acted as host to the International Engineering Congress, which met jointly with and under the auspices of the Society. The results of that joint meeting were satisfactory, in spite of somewhat discouraging obstacles overcome in organizing the convention. Papers were presented by engineers from North America, South America, Europe, Asia, and Africa, and representatives were present from many foreign countries. The congress was decidedly international in its composition and interests.

James B. Eads and James B. Francis, among the best known and most revered men in the field of civil engineering, were prominent participants in the convention in 1880. Mr. Francis, then Vice-President of the Society, called the meeting to order and on nomination of the local committee, James B. Eads of St. Louis was elected Chairman of the Convention. The association of these two great engineers with the Society's convention 50 years ago adds dignity and prestige to its present meeting in St. Louis.

Committee Launches Salary Study

To ANALYZE and digest 20,000 statements from civil engineers of all classes and grades throughout the United States—that is the project of the Society's Committee on Engineering Employment in Public and Quasi-public Offices as a part of its investigation of engineers' salaries and of the method to be pursued in increasing them.

In the near future a short questionnaire will be sent out from Headquarters asking for certain data. The success of the Committee in its undertaking to compile the most comprehensive report ever prepared on the classification and compensation of engineering positions will depend upon the cooperation received from the members of the profession. The questionnaire is to be sent to every member of the American Society of Civil Engineers and to every city and state engineering group in the country.

The Committee desires to do the following:

1. Classify types of engineering organizations by population served, cost of work performed, technical excellence, tax valuation of political subdivision, or by any combination of items which will give a reasonable criterion.
2. Determine classes of positions and allocate positions to as few general classes as possible.
3. Determine minimum experience qualifications for each position.
4. Determine which classes of positions should be included in each type of organization.
5. Determine minimum salaries for the positions.

With the cooperation of the profession, such a report can be made to have a very helpful influence on the future social and economic progress of the engineer. It is hoped that every member of the profession will answer the questionnaire personally and see that all of his professional friends and acquaintances do likewise. This will assist materially in the work of the Committee.

The amount of work necessary to analyze the enormous mass of material expected will be tedious and time-consuming, but the Committee believes that this will not be time lost if fairly accurate and complete data are made available to it.

Pending receipt of the questionnaire, it is suggested that each engineer review his economic experience since 1910, listing the positions he has occupied and the salaries received, referring to documents wherever possible, but otherwise making careful use of his memory. This should be done so that the questionnaire can be answered promptly when it arrives.

Not only does the Committee propose to analyze the past experience of the members of the profession, but it is also endeavoring to formulate comparisons with other professions, to place a valuation upon the services of the engineer to society, and to formulate arguments and a constructive line of procedure which may be followed in efforts to augment salaries where they are low, and to raise the tone and quality of the engineering profession in the eyes of the world.

ERNEST P. GOODRICH, *Chairman*

Technical Procedure Committee Active

ACTIVITIES of the Committee on Technical Procedure, which met on July 8, 1930, at the time of the annual convention of the Society in Cleveland, show varied accomplishments of value and interest to the membership.

There has been compiled a manual of Procedure for Technical Divisions, which contains an exhaustive and detailed statement of matters in connection with their history, development, duties, and personnel, and other matters which affect, or which may affect, the work of the Divisions. The Committee states that the Manual is intended to be an authoritative guide for the conduct of every-day affairs of the technical divisions and, together with the Year Book of the Society, should suffice for that purpose. To that end, the Manual will be revised and enlarged from time to time. The Technical Procedure Committee will welcome suggestions for its improvement.

Participation of the different Technical Divisions in future meetings of the Society was discussed, and a tentative list was arranged showing the possible activity of each Division at forthcoming quarterly meetings of the Society through the fall meeting of October 1931, in St. Paul, Minn.

Manuals of engineering practice are in the process of preparation by each of the Divisions. These manuals will ultimately cover the field of civil engineering practice, and it is expected that they will be so prepared and edited as to be authoritative.

It was forcibly brought out at the meeting that the Committee on Technical Procedure appears to be the most suitable agency to suggest to the Committee on Awards of *Popular Science Monthly* the names of any members of this Society who may be eligible to receive the gold medal and $10,000 prize given annually by *Popular Science Monthly* for the science achievement of greatest value to the public. The prize award is open to all scientific workers, professional and amateur, academic and commercial. The award, the largest single monetary prize in America for scientific accomplishment, is instituted with a dual purpose—to heighten the interest of the American people in scientific achievements which benefit the whole community, and to focus attention upon the many scientific workers who, without thought of personal profit, "toil to better man's control over his physical surroundings."

Contact Men for Student Chapters

AFTER considerable discussion, the Committee on Student Chapters has recommended to the Board of Direction that a "contact man" be appointed for each chapter. He should be a practicing engineer, and it should be his duty to act as a special representative of the Society to the chapter, and of the chapter to the Committee on Student Chapters. He should serve as a visible evidence to the students of the Society's interest in their welfare, and at the same time should call to the attention of the Committee any special problems or difficulties of the chapter in which the Society can be of assistance through its Committee.

This action does not imply any criticism of the faculty sponsors, whose work with and for the student chapters is, and will continue to be, most important. It is believed that a special representative of this type for each chapter, in whom the students would see no university affiliation, but whom they would consider as their particular friend from the Society, would be a distinct aid and would supplement the work of the faculty sponsors.

In accordance with the established policy of the Society, these contact men are to be nominated by the boards of directors of the local sections within whose districts the chapters are located. Several of the sections have named their contact men, but many have not yet acted. Since the school year is now opening, and it is desirable that the contact men begin to function soon, it is hoped that all may be appointed in the near future. The Committee on Student Chapters is preparing a communication to its contact members, which will be sent out as soon as a sufficient number have been appointed to justify this action.

Possibly the delays in appointment may be due in part to lack of understanding by the officers of the local sections of the desired qualifications and service expected of these contact men. It is not intended that they should supersede faculty sponsors or committees on student chapters in the local sections. The idea is, rather, that they should act in a sense as corresponding members of the Society's Committee on Student Chapters. Each of them will be expected to keep in touch with but one chapter, but he will act as eyes and ears for the Society's Committee in so far as that chapter is concerned. He should be in close contact with the faculty sponsor and with the officers of the chapter for the purpose of detecting promptly any conditions in which the Committee should take a hand, as well as to learn for the benefit of the Committee about any especially advantageous activities or methods of administration which might be applicable elsewhere. He should attend at least one meeting of the chapter during the academic year, and more if it appears advantageous.

Where local sections have committees on student chapters, the contact member should cooperate with them wherever it appears advantageous, to the end that the Society may assist through the sections, as well as through its Committee on Student Chapters, in promoting the welfare of the chapters.

Appointments as contact members are not made for any definite term. It is assumed that, as a rule, a member will serve for several years. However, changes will occur from time to time, probably much more frequently than changes of faculty sponsors.

The Committee on Student Chapters hopes and believes that, with the assistance of these contact men, its work for the benefit of the chapters will be more effective.

CHARLES W. SHERMAN
Chairman, Committee on Student Chapters

A Thousand Construction Abstracts—Manual No. 4

ONE of the worthwhile endeavors carried out by the technical divisions of the Society is brought to fruition in the publication of Manual No. 4, thanks to the cooperation of the Construction Division and the Society. Specifically, this manual is "A Selected Bibliography on Construction Methods and Plant Applied to Bridges, Buildings, Dams, Hydro-Electric Plants, Roads, Sea-Walls, Sewers, Tunnels, etc."

The actual work accomplished included the making of a thorough search for all the literature covering these topics which had appeared in either periodical or book form during the years 1917–1920 and 1923–1928, inclusive. Not only are the articles listed with the necessary reference data, but brief abstracts, condensed to 100 words or less, are given to indicate exactly what may be found in them of interest to the construction man.

Still another aid to the busy engineer has been included in addition to the abstracted notation of articles. An entire second part has been added in which all the items are listed by title only in terms of the type of equipment discussed. In this way all the material relating either to a given process or to a particular machine may be easily found.

In this booklet of 117 pages the practical note is dominant. All abstracts have been formulated by experts under the personal supervision of W. J. Barney, M. Am. Soc. C.E., for several years a member of the Executive Committee as well as Chairman of the Construction Division. Almost 1,000 references are listed.

Because this material is chiefly of interest to the construction man, copies have been sent only to the members of the Construction Division. An additional supply is on hand, however, sufficient to satisfy the needs of any member who desires a copy. A post-card request to Headquarters will bring a copy.

To those who have seen Manual No. 4, a striking resemblance will be apparent as compared with the abstracts of current periodical literature now appearing in CIVIL ENGINEERING. Except for brief intermissions, notably since January 1, 1929, a combined use of this manual and the abstracts now being printed month by month, will permit construction men to keep well abreast of the latest advances. This comprehensive manual should be of constant reference value in the office of every busy construction engineer.

Fees—Their Basis and Amount

FOR a long time engineers have needed an authoritative exposition on the question of fees to be charged to clients. Now it is here, thanks to the efforts of a Society committee. The whole matter has been prepared in the form of a tentative report, has been widely discussed by the members, revised, and through adoption by the Board of Direction at its July 1930 meeting, has received official endorsement.

In effect, this is a complete, although condensed, treatment of the various considerations affecting fees. All the methods in customary use are described and their application and limitations noted. Finally, explicit amounts or percentages are suggested as the equitable minimum return for consulting services.

In this form, as Manual No. 5, it will be sent to every member. In it he should find the answer to every perplexing question—if not the actual amounts, at least the approved basis for computing them.

It will be noted that Manual No. 5 is addressed primarily to the engineer. An epitome of this same material prepared, however, for the particular use of the client, is also being made available. It tells how the engineer gets paid for his services, of what these services consist, and what amounts comprise legitimate fees. After Board adoption this also will appear as a Society publication, Manual No. 6.

No studious treatment of such an involved topic comes into being without a great amount of effort. In the case of both Manuals No. 5 and No. 6, primary credit goes to J. Vipond Davies, M. Am. Soc. C.E., Chairman of the Committee on Fees. Other members of the committee working with Mr. Davies included H. Eltinge Breed, W. W. Colpitts, C. W. Hudson, W. S. Kinnear, J. R. McClintock, I. W. McConnell, Ralph Modjeski, R. R. Rummery, James F. Sanborn, and Ole Singstad, all Members, Am. Soc. C.E. Only a wide acceptance and use of Manuals No. 5 and No. 6 will justify the thought and effort expended on their preparation.

Obligation of an Engineer to His Former Employer

HOW to start in business on his own account is a problem which sometimes faces an engineer. The most desirable opening may be to become a "Consulting Engineer," but to succeed in this important and responsible position his experience must include, and is usually confined to, certain specialized branches of engineering. This experience has been obtained through various engagements during which he has made acquaintances, some of whom are clients of his former employers. It is among these acquaintances that he must seek future employers. How can the situation be handled so that it will be fair to his former employers?

One member of this Society, faced with this dilemma, placed the matter before the Society's Committee on Professional Conduct for a decision. An impersonal statement of the ethical question involved follows:

"For many years an engineer had been working for a consulting engineer on salary and percentage. He believed he was warranted in setting up independently in the same line of work and in the same locality, a very large city.

"He inquired of certain disinterested engineers whether it would be ethical to notify the clients of his former employer after becoming independent, realizing that some of those clients doubtless would speak well of him, and might give him some of their own work. His advisers drew a careful distinction between competing or soliciting work while representing his employer, or using false or malicious comments or comparisons, and, on the other hand, making a straightforward analysis of business that might come as a result of personality and previous contacts. They also distinguished between his employer's own clients and those brought in by him through his own influence.

"After deciding on independent practice, he conferred with his employer, and they mutually agreed on a date of resignation. Before that date he continued to bring in to the firm all work which came to him from any quarter, and he did not inform any of the firm's own clients of his plans, either directly or indirectly. On the agreed date he set up his own office and arranged to carry on temporarily certain necessary work for his old firm.

"He then called upon or wrote to certain clients of his former firm, with whom he had close personal contact. He informed them that he had resigned and set up his own office; that he believed himself to be in a position to handle work; and asked that if opportunity should arise, the addressee would speak well of him. In order to keep well within what he believed to be the ethics, he also avoided any mention of the possibility of getting work from the client, except when the client spoke of it spontaneously.

"He forwarded a statement of his experience, which of necessity listed those jobs on which he had worked while connected with his former firm, to friends and prospective clients not acquainted with the details of his work. The heading gave the name and address of his former firm, and stated that the following jobs had been done for them."

On the basis of the foregoing procedure, the member asked the following questions:

1. Can it be said that the engineer in question has been unethical in setting up a new office?
2. Was it unethical for him to inform his personal acquaintances among the clients of his former employer, that he had set up a new office?
3. Was it unethical for him to ask them to recommend him to possible new clients?
4. Would it have been unethical for him to ask these former acquaintances to give him a new job?
5. Was it unethical for him to accept a new job offered voluntarily?
6. Was it unethical for him to circulate to friends, not former clients, a list giving, with credit, his experience with his former employer?
7. An earnest effort having been made to obtain and follow disinterested advice as to procedure, to do no harm to his former employer beyond that naturally resulting from the separation of two parties, and to take away with him, so far as possible, nothing except his personal reputation and experience—can it be said that the engineer has been unethical in the conduct of his new office?

To each of these seven questions the Committee on Professional Conduct answered a categorical "No."

This particular case, together with the deliberate judgment of the Committee concerning its merits, may well form a basis for the procedure of other engineers faced with a similar contingency.

Preprints of Memoirs Available

Pending their publication in Transactions, memoirs of deceased members are to be printed only in preprint form, copies of which will be sent upon request to any member that expresses a desire for them. Civil Engineering will continue to add to the list of available memoirs. Those now available that have not been previously published in Proceedings are the following:

Stedman Bent, Affiliate; died November 26, 1927.
Axel Samuel Frederick Berquist, Member; died October 6, 1915.
John Carlisle Bland, Member; died August 16, 1927.
Robert Brown, Member; died October 20, 1929.
Maurice Wurtz Cooley, Member; died April 27, 1930.
Charles Ellett Hart, Associate Member; died January 3, 1929.
William Hausmer Hoyt, Member; died November 10, 1927.
Clark Rogers Mandigo, Member; died March 25, 1930.
Cornelius Joseph O'Connor, Associate Member; died January 29, 1929.
Claude Irvin Rhodes, Member; died May 11, 1930.
Thomas Rodd, Member; died August 3, 1929.
Ivan Oscar Shaffer, Member; died January 25, 1928.
Bronson Hasbrouck Smith, Member; died June 6, 1930.
Charles Augustus Van Keuren, Member; died April 21, 1930.

There is a source of great satisfaction in the thought that, among its many functions, the Society undertakes to record, in the annals of the civil engineering profession, the accomplishments and outstanding facts concerning the lives of members after their work has been done. While the ink is fresh and for some time thereafter, these accounts have a real sentimental value, especially for friends and relatives. Thereafter their value is historic in that they accord to the memory of the deceased a respectful honor and a proper place in the ranks of engineers who have contributed to the growth of the profession by their affiliation with a truly great national society.

Memoirs are generally written by the person most familiar with his subject; many are written jointly by two or more persons; and some are written from information in the files of the Society. While a large number of them are solicited, any member is invited to send in information that will help to make these records complete. A glance at page 101 of the 1930 Year Book reveals the fact that there are still many gaps in the complete record of memoirs. Those who are interested in furthering this cause are requested to submit any supplementary information to the Secretary, 33 W. 39th Street, New York, N.Y.

Employment Service Expanded

In addition to its customary employment bureau, the New York Office of Engineering Societies Employment Service is now able to offer to civil engineers a Letter Service Department. This Department has a carefully selected list of approximately 2,000 companies, corporations, firms, and individuals. From this list, applicants for the use of the Letter Service will be assisted in choosing fifty, one hundred, or more employers to whom letters will be written describing their qualifications and experience.

To cover cost of postage, stationery, mimeographing, and pro rata share of clerical wages, the following charges have been established:

$20.00 for 50 letters
$30.00 for 100 letters
$35.00 for 150 letters
$40.00 for 200 letters

Obviously this Letter Service will be useful only to the older and more experienced engineers, whose records are sufficiently impressive to justify their being submitted later to prospective employers. Likewise the extent to which circularization may be carried on with success is limited, as too many letters coming to the same individual advertising the availability of experienced engineers would not be desirable. However, this class of service is one in which the commercial agencies have operated with some success, and the bureau is pleased to be able to offer it at this time.

The rates quoted for this additional service are fixed to cover its cost only. In addition, the usual rates that have applied in the past will be payable for positions obtained by means of the Letter Service.

Appointments of Society Representatives

Among those recently appointed to represent the Society are the following:

Wilbur J. Watson, M. Am. Soc. C.E., has been appointed to represent the Society at the Seventy-fifth Anniversary Celebration of the École Polytechnique Fédérale, which is to be held in Zurich, November 7–8, 1930.

Franklin Thomas, Director, M. Am. Soc. C.E., has recently been selected to fill the vacancy on the Committee on Accredited Schools, caused by the resignation of F. O. Dufour, M. Am. Soc. C.E.

C. H. Howell, M. Am. Soc. C.E., Chief Engineer, J. G. White Corp. of Mexico, and

ROBERTO GAYOL, M. Am. Soc. C.E., Consulting Engineer, City of Mexico, at the request of the Sociedad Cientifica "Antonio Alzate," represented the Society at the Second Scientific Congress held in the City of Mexico, September 9, 1930.

BLAKESLEE BARNES, M. Am. Soc. C.E., of the Prodotti Chimici Napoli, Rome, Italy, will attend, as a representative of the Society, the meeting of the Società Italiana per il progresso delle Scienze, to be held on September 7–14, 1930.

JOHN R. BAYLIS, Assoc. M. Am. Soc. C.E., of Chicago, has accepted appointment as the Society's representative on the Sectional Committee on Specifications for Portland Cement.

GEORGE E. BEGGS, M. Am. Soc. C.E., was recently selected to fill the vacancy on the National Research Council, caused by the death of Allen Hazen.

A Foresight on October Proceedings

SOME two weeks after this copy of CIVIL ENGINEERING comes into the possession of members, the first issue of PROCEEDINGS, under the new publication policy, will make its appearance. That is, henceforth, CIVIL ENGINEERING will be in the mails for delivery on the first of the month, and PROCEEDINGS on the fifteenth.

The forthcoming PROCEEDINGS will undoubtedly impress our members as somewhat less bulky than the average issue of the last two years. The answer is expressed by the phrase, "Decks cleared for action." The most important reduction in volume is due to the transfer of "Society Affairs" from PROCEEDINGS to CIVIL ENGINEERING and to the omission of memoirs. Furthermore, the abstracts of papers read at Society meetings will also appear in the new magazine.

Now then, to a careful review of what PROCEEDINGS holds out as a promise for its October issue: an outstanding paper on the theory of similarity; a valuable presentation of a means for determining rainfall intensities; and a comprehensive progress report of the committee of the Sanitary Engineering Division on filtering materials for water and sewage works.

THE VALUE OF MODELS

The widely spreading interest in hydraulic laboratories and in model experiments of every kind give an especially timely value to the paper "Theory of Similarity and Models," by Benjamin F. Groat, M. Am. Soc. C.E. He begins with Newton's Law, $G \propto \frac{V^2}{D}$, and accepts it for the present purpose as being perfectly general. He shows that it covers every possible type of dynamic model.

In creating an exact model from its prototype, it is not enough to consider the theoretically exact scale reductions for the dimensions. Corresponding scale reductions of other qualities must be considered. "It is suggested," says Mr. Groat, "that materials, including fluids, should be sought, made, or arranged so as to adapt them especially for service in models."

Because the author's viewpoint is basic, and because it takes exception to some of the generally accepted theorems of similarity, his paper should be read with interest and should be actively discussed by all who can add to it from their own experience.

FORMULAS FOR RAINFALL INTENSITIES OF LONG DURATION

A vast fund of information concerning rainfall, its extent and its characteristics, is being gathered by various agencies all over the world. Rainfall records covering an important and appreciable period of years are being preserved for many specific regions. It is difficult to imagine, nevertheless, a time when civil engineers will not have to make interpolations or estimates of some kind to supply missing information at some distant point midway between two effective rainfall stations. For the history of rainstorms of long duration, the problem becomes correspondingly more acute.

The object of the paper on "Formulas for Rainfall Intensities of Long Duration," by Merrill M. Bernard, M. Am. Soc. C.E. is to present and discuss a series of formulas for predicting frequencies applicable to rainfall duration periods of 120 to 6,000 min. in the Mississippi Valley. Experience in the rational method of flood-flow analysis used in storm-sewer design is applied to the broader field of small-stream flow.

All in all, Mr. Bernard presents, in practical and usable form, the results of two valuable researches and suggests a new means for the further study of rainfall intensity and its relation to the length of storm period, frequency of occurrence, and locality.

FILTERING MATERIALS FOR WATER AND SEWAGE WORKS

Since its appointment by the Sanitary Division in May 1925, the Sanitary Engineering Division's Committee on Filtering Materials has expended a tremendous amount of effort and has accomplished many significant results. The four reports preceding this one were published in PROCEEDINGS, March 1926, April 1927, April 1928, and September 1929.

The present progress report, giving the results of activities during 1929, is concerned almost entirely with a further study of the sodium sulfate soundness test. Thirteen materials-testing laboratories have cooperated with the Committee in making these studies. The descriptions of testing methods and standard instructions, described in Appendix I, are quite complete, and the findings of the various laboratories have been admirably coordinated for a detailed study by those who are interested in this subject.

The report should receive the most careful attention of sanitary engineers, and discussions are expected to be lively and numerous. The Committee plans to use the material in these progress reports with all open discussion thereon and to publish a final report to be used possibly as the basis for a manual.

DISCUSSIONS

On the inside front cover of PROCEEDINGS it has been customary to publish a list of papers which, with the newer papers published in that issue, are open for discussion. The present list, which will be found next to the contents page, contains more than 20 titles, some of which have drawn an almost constant stream of lively discussion since February. In the October PROCEEDINGS there will be found a frank expression of professional opinion on several of these papers.

APPLICATIONS FOR ADMISSION AND TRANSFER

Relegated to "the rear of the procession," but none the less important, is that imposing list of applicants for admission and transfer into the various grades of Society membership. The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer, and in order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

It is the duty of every member to examine these lists carefully each month and to supplement or correct the information given, wherever necessary. All such information is considered strictly confidential.

News of Local Sections

LOCAL SECTIONS CONFERENCE

ON JULY 8, 1930, a Local Sections Conference for the Northern Region was held under the auspices of the Regional Meetings Committee at the time of the Annual Convention at Cleveland, Ohio. Representatives were present from the following local sections:

Buffalo
Central Ohio
Cincinnati
Dayton
Detroit
Duluth
Illinois
Iowa
Lehigh Valley
Milwaukee
Northeastern
Northwestern
Philadelphia
St. Louis

This was the first meeting of its type held under the new Functional Expansion Program, under which the conference was called. The various items of business attended to included: a discussion of the character of future meetings; possible features which might justify Technical Division sessions at these regional meetings; methods of attracting attendance at meetings; the duties of a local standing committee in each local section to work with the Society Committee on the duties assigned to it under the Functional Expansion Program; the nation-wide discussion at local sections of assigned topics; and, finally, the time and place for the next meeting. Definite action was taken on the last question, and it was decided to hold the next meeting at St. Paul, Minn., in October 1931.

In concluding the conference, Secretary Wallace, of the American Engineering Council, spoke on the work of the Council as shown in relation to the recent session of Congress. He pointed out that engineering matters seem to have received successful attention in this last Congress. The success of the Council in helping to secure proper recognition for the engineering staff of the Federal Radio Commission was pointed out. This is perhaps the first time in national legislation that engineering has been recognized as co-equal and coordinate with the legal profession. In closing his remarks, Mr. Wallace explained that individual citizens can make their appeals to Congress most effective by communicating directly, personally, and individually with their Congressmen. He also cited the successful method of the St. Louis Engineers Club in cultivating the acquaintance of the legislators from Missouri and recommended that other sections try a similar scheme.

Arizona Section

At the luncheon meeting held July 16, 1930, at the Arizona Club, Director Franklin Thomas, of District No. 11, and the Section's guest, reported on the interesting features of the Cleveland meeting of the Society. Twelve members attended.

PRESENTED TO
DAN KEFFER CONGER JR
MEMBER
UNIVERSITY OF ARIZ STUDENT CHAPTER
ARIZ SECTION
AMERICAN SOCIETY OF CIVIL ENGINEERS
FOR
TRUSTWORTHY CHARACTER PROFESSIONAL ZEAL AND SOUND JUDGMENT WHICH ARE THE TRUE FOUNDATION OF SUCCESS IN THE ENGINEERING PROFESSION
APR 19 1930

At the April meeting of the Section, a plaque was presented to D. K. Conger, Jr., a member of the Student Chapter, and an honor student at the University of Arizona.

Colorado Section

Following the dinner at the 193rd regular meeting, held at the Denver Club on June 9, 1930, Vice-President Funk called the meeting to order and introduced, as the guest speaker, D. D. Gross, Chief Engineer for the Board of Water Commissioners. Mr. Gross spoke on the subject, "The Construction of a 66-in. Reinforced Concrete Conduit," supplementing his descriptions with photographs. Discussion was offered by W. B. Freeman and E. C. Jansen.

After the entertainment, a brief business meeting was held, at which Arthur Ridgway read the report of the committee appointed to consider the subject of the proposed redistricting, as set forth in a letter and a blue print received from Mr. Seabury, dated May 24, 1930. The report of the Committee was accepted and was ordered to be transmitted to the Secretary of the Society.

The election of the following officers for the ensuing year was announced: President, Norman W. Funk; Vice-President, C. L. Eckel; Secretary and Treasurer, Lyman F. Copeland. Twenty were present at the meeting.

Connecticut Section

Members of the Yale Student Chapter in the Senior Class, and Allen P. Richmond, Assistant to the Secretary of the Society, were guests at a dinner meeting held at the Church-at-Wall Tea Room in New Haven on May 21, 1930. Mr. Richmond addressed the meeting on "The Work and Aims of the Society" and told the students of the advantages of continuing their membership in the Society. Thirty-seven were present.

On July 15, 1930, a dinner meeting to welcome Pres. John F. Coleman was held at which Profs. H. P. Hammond and C. F. Scott were guests. After the dinner and informal round-table discussion, the meeting adjourned to Mason Laboratory where Mr. Coleman addressed the session of the Yale Summer School for Engineering Teachers on the subject of "The Mississippi River Problem." The attendance at the dinner meeting was 25.

Duluth Section

A report by William E. Hawley, Secretary of the Section and its delegate to the Cleveland Meeting of the Society, was heard with considerable interest at the July 21, 1930 session.

On August 18, 1930, a luncheon meeting was held at the Ridgeview Golf Club. Leland Clapper carried away the best score in the afternoon of golf which followed the luncheon.

Georgia Section

Secretary J. A. Higgs reports that the membership now totals 96, of which 65 are resident in Atlanta. Preparations are being made to welcome and entertain President Coleman during his visit to the Section in early October. The Board of Directors of the Section has appointed a local Functional Expansion Program Committee to cooperate with the Society's committee of the same name.

On September 8, a luncheon meeting devoted to aeronautics was held at the Atlanta Athletic Club. Pres. William A. Hansell presided. C. H. Dolan, Assistant Operations Manager, Eastern Air Transport, who served in the Lafayette Escadrille, explained the operations of his company at Candler Field. Further details were made clear by John K. Ottley, Jr., Commercial Representative; Fred Schwaemmle, Depot Superintendent; W. R. Crippen, Purchasing Agent; and F. E. Gray, Radio Engineer. Prof. Montgomery Knight, head of the Daniel Guggenheim School of Aeronautics at the Georgia School of Technology, now being built, explained that this school will be devoted exclusively to aeronautical engineering research. Professor Knight believes it will become the best school of its kind in the South.

Los Angeles Section

The Board of Directors of the Los Angeles Section are intensely interested in the Functional Expansion Program which was outlined by Secretary Seabury on his recent visit to the Coast, and are actively engaged in carrying out certain phases of the recommended procedure.

The Student Member awards made yearly by the Section were presented to Loren East, President of the Student Chapter at the University of Southern California, and to Donald Barnes, of the California Institute of Technology. These awards consist of a junior membership in the Society and the first year's dues to the Society and to the Section.

Secretary O. A. Stone reports the Section membership as of September 1 to be 507.

Illustrative of the manner in which engineering matters may be made interesting to the public was the program given before 150 members and guests of the Los Angeles Section at the meeting held on September 10, 1930, at the Engineers Club.

Through the courtesy of the Southern California Telephone Company, the promulgation, transmission, and reception of sound; the mechanics of human speech; the operation of the human ear; radio and chain broadcasting; and amplification and talking pictures were explained in an illustrated talk by Mr. P. L. Johnson of the Engineering Staff of the company. Aided by seven assistants, lantern slides, animated cartoons, motion pictures, and a large truck load of electrical equipment, Mr. Johnson gave one of the most instructive, interesting, and entertaining programs which has ever been offered before the Los Angeles Section. A highly technical subject was explained with such skill and simplicity as to be readily understandable and intensely fascinating.

The care and thought exercised by the Southern California Telephone Company in the preparation of such a program is to be commended and unquestionably pays satisfactory dividends in the feeling of good will thereby engendered. The training of engineering employees by the utilities and industries as public speakers and publicity agents for engineering accomplishments is even more commendable from the standpoint of establishing the value of the engineer in the mind of the public.

NORTH CAROLINA SECTION

The first volume of the Technical Papers of the North Carolina Section was published in April. This volume is confined to the proceedings of the meeting held at Greensboro, April 18–19, 1930. It is proposed to publish annually the proceedings of the Section's meetings. The next meeting of the Section will be held jointly with the North Carolina Society of Engineers.

PROVIDENCE SECTION

On May 20, 1930, the Section made a field examination of the Washington Bridge, which was followed by dinner at the Art Club. At the request of Chairman W. G. Brenneke, Vice-Chairman James L. Murray, of Warwick, R.I., is handling the affairs of the Section. Mr. Murray attended the meeting of the Council of the Providence Engineering Society as representative of the Section.

SACRAMENTO SECTION

On July 29, 1930, Charles S. Pope, Past-President of the Section, read a paper on "Profession Consciousness in Engineers." Mr. Pope paid a fine tribute to President Hoover, his friendship with the President dating back to the time when both were students at Stanford University. Thirty-six of the members were present.

Drury Butler, Past-President of the Section, who recently returned from a trip to the Atlantic Seaboard, and an inspection of the great plant of the Utah Copper Company, at Bingham, Utah, read a paper on the method of mining and treatment of copper ore at that plant. Thirty-six attended this meeting on August 5, 1930.

A paper on "Improvements to State Highways in the Vicinity of Sacramento" was read by George McCoy, Administrative Assistant to the State Highway Engineer. Thirty-five were present.

At the August 19, 1930 meeting of the Section, R. S. Fuller, Manager of the Gas Department of the Pacific Gas and Electric Company, of San Francisco, read a paper on "The Importation of Natural Gas from Southern California to Northern California." Surveys for the pipe line, which was to have a capacity of 13,000,000 cu. ft. daily, were started in July 1928, and gas was being delivered in the San Francisco Bay area by August 1929. Natural gas proved so popular that additional pipe lines had to be built, and 40,000,000 cu. ft. are now begin delivered to Northern California from the Buttonwillow and Kettleman Hills daily. Motion pictures of the construction were shown. Thirty-four attended.

On September 2, 1930, T. H. Dennis, Maintenance Engineer for the State Division of Highways, read a paper on "Emulsified Asphalt," illustrated by motion pictures of the model highway at Yreka, recently completed as a portion of the Pacific Highway.

SAN DIEGO SECTION

At the July 24, 1930 dinner meeting held at the Golden Lion Tavern, Col., J. L. Bacon, President of the Boulder Dam Association, presented a résumé of recent developments between opponents and proponents of this project.

SAN FRANCISCO SECTION

Prior to the entertainment, at a dinner meeting held at the Engineers' Club, June 17, 1930, President Dewell spoke on recent activities of the Section. The U.S. Coast and Geodetic Survey has been urged to undertake to determine the periods, amplitudes, and accelerations of earthquake waves; and the Building Code Committee of the Section is continuing its work on a uniform building code, California edition.

Following the entertainment, which consisted of a radio program, the business meeting was held. W. L. Huber spoke briefly concerning the late C. I. Rhodes, member of the Section, who passed away on May 11, 1930. A letter was read, which had been signed by 51 engineering employees of the City and County of San Francisco, expressing appreciation of the activity of the Section and its officers in regard to the report of the Civil Service Commission on Classification of Dues and Standardization of Salaries. H. F. Gray and Philip Schuyler presented interesting and amusing discussions on "How to Write an Article for a Technical Periodical."

The technical program was marked by an illustrated lecture given by Fred C. Scobey, Senior Irrigation Engineer, U.S. Division of Hydraulic Engineering, on the subject of "Water Conduit Surfaces and Flow Conditions in Terms of Carrying Capacity, Particularly the New and Unusual." The attendance at the dinner was 83, and at the business meeting, 95.

SYRACUSE SECTION

Activities of the year 1929–1930 were reviewed at the annual meeting of the Section on May 26, 1930. During the past year affiliation with the Technology Club of Syracuse has been found satisfactory, and under the auspices of this Section the following lectures were presented before the Technology Club: "Flood Control Work in the Ohio Valley," by Charles H. Paul; "Traffic Management and Control," by W. B. Powell; "Military Bridges," by E. F. Robinson; and other lectures by W. W. Wiard and A. P. Saunders. The average attendance at the lectures was 165.

The Section made an investigation of alleged fraud by an engineer, not a member of the Society, in obtaining a state engineer's license. The evidence was presented at a hearing in Syracuse by the State Licensing Board. No decision has been rendered.

TACOMA SECTION

On June 9, 1930, Mr. Elwell, Bridge Engineer of the Washington State Highway Department, gave a talk on special features of design of several bridges now under construction by the State. Forty attended the meeting, which was preceded by a dinner at the Winthrop Hotel.

On July 14, at a dinner meeting at the Winthrop Hotel, Capt. Leander Larson, Q. M. C., spoke on construction problems at Fort Lewis. Capt. Larson also outlined the work proposed for the immediate future at the Fort. Thirty attended.

On August 11, Maj. Joseph Jacobs, Director of the American Society of Civil Engineers, gave many interesting details in his talk on the Society's activities at the Cleveland convention. The meeting was preceded by a dinner at the Winthrop Hotel.

On September 8, the Section had a dinner and meeting at the Olympian Hotel, Olympia, Wash., at which Mr. George T. Yantis, Chairman of the City Plan Commission of Olympia, was the speaker. His subject was the "Capital City Plan."

TEXAS SECTION

At the spring meeting, March 20–21, 1930, held at Waco, O. N. Floyd, Consulting Engineer of Dallas, presented a paper entitled "Lake Waco Water Supply Project."

The Texas Engineer, the publication of the Texas Section, announced in its August number that the fall meeting of the Section will be held in Houston, October 24 and 25. James E. Pirie, President, represented the Section at the Local Sections Conference in Cleveland, July 8.

Student Chapter News

OFFICERS of Student Chapters are unquestionably outstanding men, but it is not easy to collect concrete evidence of this fact, in the form of commencement honors, without circularizing the universities or patronizing a clipping bureau. However, a few cases were noted in June newspapers, and it is hoped that information concerning others may be sent in. Aside from general interest in the high quality of the chapter officers, the list thus far noted is published because these young men have worked loyally for this branch of Society activities.

George D. Champlin, President Cooper Union Chapter, scholarship for study in civil engineering.

Frederick Glenz, Secretary Brooklyn Polytechnic Institute Chapter, C.E., summa cum laude.

James J. Ledwith, Secretary Manhattan College Chapter, medal for natural science.

J. C. Myers, Jr., President Princeton Engineering Society, high honors in engineering.

Robert M. Schafer, Secretary Princeton Engineering Society, high honors in engineering.

Alfred M. Wyman, Jr., President New York University Chapter, fellowship for high scholarship.

ITEMS OF INTEREST

Engineering Events in Brief

Your Professional Record

The file of professional records at Society Headquarters now numbers 6,280 out of a total membership of approximately 14,500. In March, 1927, an appeal was broadcast for the filing of more of these data, following a mailing of blank forms some months previously.

It may not be amiss to suggest again—nay, urge—that the unrecorded members either dig up those biographical and professional blanks, or send for new copies, and then "accomplish them," as is said in the army.

To repeat briefly the use to which the data are put, the most frequent is that of the employment service or other inquiries relative to engagements. Another is in connection with expert advice on technical topics of many phases. If additional data were sent in from time to time to keep the record up to date and by members who, hitherto, have neglected it, this file might become the most authoritative contemporary record of civil engineers in the United States. Indeed, it is already that. Obviously, however, a fragmentary file means that not only may the collective data be less than representative, but that opportunity may sometimes be forced to pass by some worthy member.

A postal card is all that is necessary to start a blank by return mail.

Public Spirited Engineers

Apparently for the first time in the United States, an engineering council has been instituted as an integral unit of a chamber of commerce. This unique idea seems to have originated within a local section of The American Society of Mechanical Engineers at Savannah, Georgia, and the chamber of commerce of that city adopted the scheme. The council includes engineers of all branches of the profession, and about 40 members attended the first supper meeting on June 26.

From the one-page constitution of this Engineering Council, we read that:

"The objects of this association shall be:

"1. To study and consider all technical matters relating to the welfare of Savannah and Savannah territory as may come to its attention or be referred to it by the Chamber of Commerce; to make recommendations thereon to the Chamber of Commerce; and to act thereon in behalf of the Chamber of Commerce when requested so to do.

"2. To enlist and encourage the interest of all individuals in the various engineering services in civic matters and to promote friendly relations between individuals and groups within the City who are engaged in technical services."

Such an organization has many interesting possibilities, and its career should be watched with interest by other groups with similar problems to solve.

Merritt H. Smith Memorial

One of the monumental engineering structures frequently exhibited to admiring visitors in and around New York City is the Kensico Dam near White Plains. This magnificent piece of masonry now has an additional attraction to the engineer inasmuch as it holds one of the few public memorials to the life and accomplishments of a civil engineer. It is in memory of the late Merritt H. Smith, M. Am. Soc. C.E. It notes his span of life, 1862–1926, and proclaims him as "Engineer for Forty Years of the Water Supply of the City of New York. Colonel of Artillery in the Great War."

This impressive plaque stands as a memorial to an eminent engineer and as a fine tribute to his host of friends, who supplied the means for its erection and over $1,000 for its maintenance. To provide for its permanent administration, the committee requested the Society to take the responsibility of seeing that the memorial is kept permanently in good condition and that any necessary repairs are promptly made. The Society, on its part, through action of the Board of Direction, has now accepted this trust.

COMING EVENTS

American Society of Civil Engineers
Fall Meeting convenes in St. Louis
October 1–4, 1930

Sixth International Road Congress
A world-wide gathering, opens in Washington, D.C.
October 6 to 11, 1930, at the invitation of the United States Government.

American Engineering Council
The Administrative Board meets in Washington, D.C., October 17–18.
President C. E. Grunsky of American Engineering Council will preside.

A Quick Survey of Current Engineering Literature

To be widely read is a desire of the up-to-date civil engineer. This desire will be partially fulfilled through the bringing of Engineering Index Service, a division of the American Society of Mechanical Engineers, to the members of this Society. That portion of the Service covering the field of Civil Engineering literature is to be supplied monthly to members through Civil Engineering under the heading *Current Periodical Literature*. The value of the service to members of the Society is so great that many thousands of dollars will be spent annually in bringing the information to them. The cost of the Engineering Index Service for the field which will be covered would be over four hundred dollars to each individual subscriber—a total of several hundred thousand dollars if members subscribed individually.

More than 1,800 domestic and foreign technical publications are read regularly by a staff of editors, each an engineer, in the preparation of this service. Pertinent information is abstracted and classified by these editors from every article of possible interest to civil engineers, and the material is sent out in card index form to this Society. Nearly a hundred abstracts are to be published monthly out of several hundred which will be received; the attempt being to include in the published list all the more important of the articles, as judged by their abstracts.

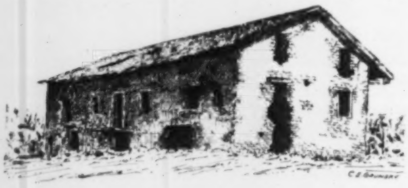
New Pavement Has Steel Base

Many advantages are claimed for a section of experimental roadway installed in the Sangamon County highway system, Illinois. Not only does this test section embody an entirely new idea in road construction, but, as it has a steel foundation, it may open up a new market for steel. The base construction, of high-chromium, corrosion-resisting steel sheets, is laid on a carefully prepared and rolled subgrade. For experimental purposes, both plain and corrugated sheets are used, with curbs and stiffeners of various designs. A bed of bituminous-sand mastic supports the surface layer of vitrified brick filled with asphalt.

The National Paving Brick Manufacturers Association, G. F. Schlesinger, M. Am. Soc. C.E., Chief Engineer, which is cooperating in the test, expects this new pavement to show decided advantages over old methods of construction—elimination of cracking; flexibility throughout, but with no permanent deformation under traffic; durability secured through the use of rust-resisting materials; and the uniformity and low cost of a factory-made product.

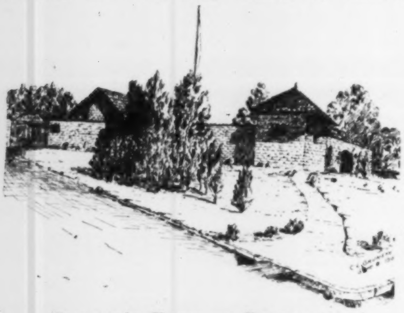
A Sacramento Shrine Restored

Those who attended the Spring Meeting at Sacramento will recollect that on the first morning C. E. Grunsky, Past-President of the Society, detailed some interesting reminiscences covering many years of familiarity with the city. Interwoven in the thread of his remarks was the story of Sutter's Fort, the original building from which Sacramento later grew.



Sutter's Fort as It Appeared in 1884 before Restoration

Built of adobe (sun-baked clay brick), this enclosure, which originally covered several blocks with many buildings within, finally succumbed to the ravages of time until, in 1884, only a single dilapidated building remained. Aware of the historic interest attached to this site, public-spirited citizens and organizations finally secured the necessary funds to restore the site to a condition of permanent stability. How well this was accomplished was later made apparent to the Society members who were privileged to visit the Fort itself.



Sutter's Fort as Restored
Sketch from Nature

In the course of the investigation, an interesting bit of detective work with an engineering flavor was necessary. Telltale marks had long since been obliterated by decay and by the advances of municipal growth. However, one of the earlier tenants of the Fort, a blacksmith, recalled the location of his coal bin. Fortunately, excavation disclosed the exact limits of this room by means of the residue of coal dust still perceptible in the cut. Based on this controlling point, surveys permitted the extension of the various buildings and structures whereby the exact alignment could be retraced.

Similar problems involving lost boundary lines in woods or in rough country are more or less common occurrences to the land surveyor. That the resulting restoration was successful is amply verified by the appended sketches made and furnished by Mr. Grunsky. Often it is given to engineers to make history; this is one of the unusual instances when they were permitted to reconstruct it.

Transactions Ready Soon

Thirty-five papers, with full discussions and closures, three symposiums, three reports of the Irrigation Division, together with memoirs of deceased members, constitute the "makeup" of the 1930 Transactions. This volume should be in the hands of members by the latter part of the month, or perhaps early in November.

It would seem difficult to compile a group of papers containing information useful to all members with their wide variety of special interests in the broad field of civil engineering, yet Vol. 94 seems adequately to do this. Whether the member be interested in the several branches of hydraulics, in structures, reclamation, sanitation, or surveying—all these and numberless other matters he will find discussed. Expert views are presented: expert opinions pro and con are set forth in discussion.

Out of many conflicting thoughts, a fairly well-defined idea usually emerges. It represents—at least as well as any treatment of a mooted question can represent—an up-to-date consensus by those experts who are willing to be quoted on the particular topic.

Older members of the Society who have gathered together a sizeable library of Transactions have good reason to feel that they have a permanent record of the successive stages of progress made by the profession in this country. In the complete set, for those fortunate enough to possess it, this latest volume will occupy the center of the sixth section in a standard-sized bookcase.

It is certain that it will be opened and studied carefully many times before the aging of its binding changes its status from that of a "new book" to that of one of many books in the history of civil engineering thought. For its merits the Society is indebted to the interest, loyalty, and labor of the 200 or more contributors listed in the index.

Boulder Dam Renamed to Honor Hoover

The commencement of work on the Boulder Canyon Project was formally celebrated at Las Vegas, Nev., on September 17, 1930, when Dr. Ray Lyman Wilbur, Secretary of the Interior, drove a spike of Nevada silver into the first railroad tie on the construction railroad. In honor of a great engineer who was largely responsible for starting this vast project, Secretary Wilbur at the celebration named the huge structure, which is to be built in the Black Canyon gorge of the Colorado River, the Hoover Dam. The hundred-mile long reservoir back of the dam will have a similar appellation.

Congress has placed the Boulder Canyon Project under the Department of the Interior, headed by Secretary Ray Lyman Wilbur. The work is being handled by the Bureau of Reclamation under the direction of Elwood Mead, Commissioner of Reclamation. In the manuscript furnished by Dr. Mead for his article appearing in this issue of Civil Engineering, he announced the personnel engaged in the work of the Bureau as follows:

All engineering and construction work including the Boulder Canyon Project, is under the direction of R. F. Walter, M. Am. Soc. C.E., Chief Engineer, with headquarters at Denver, Colo., assisted by a staff composed of: S. O. Harper, M. Am. Soc. C.E., General Superintendent of Construction and Acting Chief Engineer in the absence of the chief engineer; J. L. Savage, M. Am. Soc. C.E., Chief Designing Engineer in charge of engineering and designing for all projects, including the Hoover Dam; W. H. Nalder, M. Am. Soc. C.E., Assistant Chief Designing Engineer; L. N. McClellan, Member, American Institute of Electrical Engineers, Electrical Engineer in charge of all electrical engineering matters; B. W. Steele, Assoc. M. Am. Soc. C.E., Senior Engineer in charge of the structural design of dams; Ivan E. Houk, M. Am. Soc. C.E., Senior Engineer in charge of technical studies; C. M. Day, Member, The American Society of Mechanical Engineers, Senior Engineer in charge of mechanical designs; H. R. McBirney, M. Am. Soc. C.E., Senior Engineer in charge of the design of canals and canal structures; and E. B. Debler, M. Am. Soc. C.E., Hydrographic Engineer in charge of water-supply studies and investigations of proposed projects. Walker R. Young, M. Am. Soc. C.E., is Resident Engineer in charge of all field investigations and all the construction at Hoover Dam, with headquarters in Las Vegas, Nev. Homer J. Gault, M. Am. Soc. C.E., is the engineer in charge of field investigations of the All-American Canal.

Consultants for U.S. Army Corps of Engineers

Of especial interest to civilian engineers is one of the provisions of the River and Harbor Act of July 3, 1930 (No. 520). Under Section 6 it states that "The Chief of Engineers is hereby authorized to engage under agreement when deemed necessary, expert assistance in the various arts and sciences....upon terms and rates of compensation for services and incidental expenses in excess of the maximum of the salaries authorized by the Classification Act of March 4, 1923, as amended by the Act of May 28, 1928; and all agreements heretofore entered into for such purposes are hereby validated to the amount of the current rates charged for such services."

By its terms the explicit statement of this act gives wide latitude for the hiring of consulting engineering service by the Corps of Engineers. No longer will it be necessary for capable engineers to accept insignificant fees for the satisfaction of serving their government. On the other hand, the most capable and busy man will be enabled to serve without personal sacrifice. Doubtless, this act will have far-reaching consequences.

Sixth International Road Congress

America will play host to engineers and road constructors from all over the globe when the Sixth International Road Congress is called to order on Monday, October 6, 1930, in Washington, D.C. This auspicious event will be the first occasion on which such an important gathering to consider highway interests has been privileged to meet in this country. Congresses have been held heretofore at intervals of every few years in various parts of Europe. The first, in Paris in 1908, was followed by others in Brussels, in 1910; London, in 1913; Seville, in 1923; and Milan, in 1926.

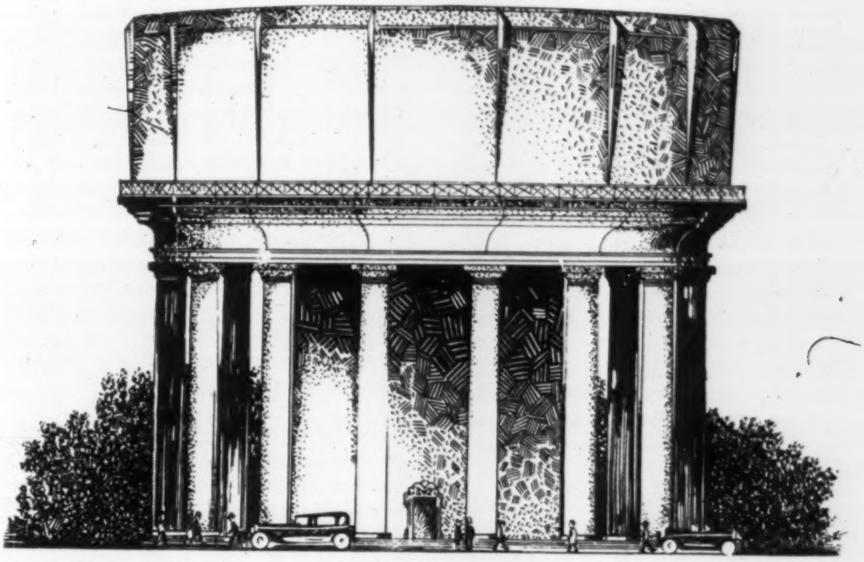
For the present congress two major divisions of study are to be recognized—construction and maintenance on the one hand, and traffic and administration on the other. Technical questions involved under the first heading will include the study of results obtained by the use of cement, brick, and asphaltic materials as well as the general question of road construction in new countries. The second general study, which involves administration, will include such items as methods of financing, highway transport, traffic regulation, and parking. To accommodate this program, events will be scheduled throughout the entire week, beginning October 6. Sessions in the morning and afternoon will, in general, be devoted to the technical meetings and to an exposition by the American Roadbuilders Association. Evenings will be reserved for social events, receptions, and similar occasions.

Meeting at the invitation of the United States Government, the congress will enjoy an official status. President Hoover has shown his great interest by accepting the position of the honorary presidency. His entire Cabinet and the chairmen of the Congressional committees dealing with international affairs and post roads are on the honorary committee.

An impressive list of delegates to this important meeting has already been announced. Without doubt it will become the Mecca of leading governmental officials and engineering authorities from all the important nations. In this list will be included many members of the Society, both American and foreign. The fall meeting of the Society in St. Louis will be over by the time the Road Congress assembles so that there will be no conflict of dates. American engineers are expected to avail themselves in large numbers of this opportunity for contact and exchange of ideas with outstanding minds of the present age.

Immediately following the congress, 300 selected representatives from more than 60 foreign governments are to be conducted on one of three carefully planned highway tours of three weeks duration. The fortunate delegates will be divided into three groups, of which one will journey in the East as far as Boston, another will travel south to Florida, while the third will go west as far as Minneapolis and Des Moines.

The Allen Hazen Tower



A noteworthy tribute to Allen Hazen and to his accomplishments was recently voted by the Board of Water Works Trustees, of Des Moines, Iowa, when a water tower which had been planned by Mr. Hazen and which was being erected under his direction, was designated "The Allen Hazen Tower." This fitting action was suggested by Charles S. Denman, General Manager of the Des Moines Water Works.

According to the official minutes of the Board:

"The approval of this proposal was supported by every member of the Board with expressions of sorrow and sincere regret over the loss sustained in the passing of Mr. Hazen, not only as an eminent engineer of international reputation and a sympathetic counselor, but a friend whose simplicity of manner and mode of living and whose culture and friendly spirit drew to him in close contact those with whom he had dealings."

The tower is now nearing completion at 48th Street and Hickman Boulevard, Des Moines. As indicated in the sketch, the structure will be imposing in appearance. It has a height of 100 ft. and a diameter of 130 ft. It is surrounded by 15 columns, each 6 ft. in diameter and 50 ft. high.

National Hydraulic Laboratory Assured

A testimonial dinner was given in New Orleans, July 21, by the Louisiana Engineering Society to honor Joseph E. Ransdell for his services to the engineering profession in waging a successful seven-year fight to secure a national hydraulic laboratory. The Honorable James O'Connor, of Louisiana, who introduced the Hydraulic Laboratory Bill in the House of Representatives and secured its passage by that body, was among the guests present at the dinner. The honoring of Senator Ransdell achieved national significance not only because it celebrated the passage of a very important piece of legislation, but also because it gave professional engineers a chance to recognize and honor one who had secured legislation which had received the united support of engineers of the United States.

As previously reported in the August Proceedings, the National Hydraulic Laboratory Act was signed by the President on May 14, 1930. This legislation was known in the Senate as the Ransdell Bill, S. 3043, and in the House as the O'Connor Bill, H.R. 8299. It authorized the establishment of a National Hydraulic Laboratory in the Bureau of Standards, of the Department of Commerce, and the construction of a suitable building to house it. The Laboratory is to be used for the determination of fundamental data used in hydraulic research and engineering, involving such research as the behavior and control of river and harbor waters, the study of hydraulic structures and water flow, and the development and testing of hydraulic instruments and accessories. The various branches of the Federal Government, as well as any state or political subdivisions of it, may use the National Hydraulic Laboratory for the study of problems arising from projects now under the jurisdiction of these state or political subdivisions.

An appropriation not in excess of $350,000 goes with the authorization. This is to be expended by the Secretary of Commerce for the construction and installation of a suitable hydraulic laboratory building and the equipment, utilities, and appurtenances that may be necessary.

NEWS OF ENGINEERS

H. A. **Daae** is now Contracting Engineer for the Clark and Henery Construction Company, 601 Chancery Building, San Francisco, Calif.

Eugene J. **Vayda** recently has made a connection with R. G. and W. M. Cory, Architects and Engineers, 30 Church Street, New York, N.Y.

L. R. **Viterbo**, who has been President of the Reinforced Concrete Company of St. Louis, has opened consulting offices in St. Louis, Mo., under the firm name of Brüssel & Viterbo.

Thomas Pettersen is now Chief Structural Engineer, MacDonald Engineering Company, Russo-American Chamber of Commerce, Ilyinka 6, Moscow, U.S.S.R.

Dana Young, who has been an instructor in engineering mechanics at Yale University, is now associated with the United Engineers and Constructors, 112 North Broad Street, Philadelphia, Pa.

Marshall Morris, formerly with the Kroeger-Brooks Construction Company, of San Antonio, has transferred his connection to the Clem Anderson Construction Company, 1010 West 6th Street, Amarillo, Tex.

A. T. **Hopkins** has been promoted from Assistant Valuation Engineer to Valuation Engineer of the Michigan Central Railroad, with offices at Detroit, the Michigan terminal of that railroad.

J. E. **Jewett**, who has been Designing Engineer, Division of Sewers and Streets, Miami, has recently moved to St. Louis, where he is located in the United States Engineer Office, 815 Victoria Building.

A. L. **Vedder** has been promoted to Superintendent of Surveys, 52 City Hall, Rochester, N.Y. He was formerly Deputy Superintendent of City Planning of Rochester.

Murray Blanchard has recently resigned as Hydraulic Engineer, Division of Waterways, State of Illinois, and has opened a consulting office at 205 West Wacker Drive, Chicago.

John T. **Fetherston** has resigned as Vice-President, Sterling Salt Company, Cuylerville, N.Y., and has become associated with the Selden Company, manufacturers of chemicals, McCartney Street, W.E., Pittsburgh.

John C. **Pritchard**, formerly Director, Public Utilities, City of St. Louis, is now Treasurer of Russell and Axon, Consulting Engineers, State Bank Building, St. Louis. The firm specializes in airports and municipal engineering.

O. N. **Floyd**, of the engineering firm of Floyd & Lochridge, Dallas, Texas, will devote much of his time for the next six months to the Government's Mississippi River flood relief project at Bonne Carre Spillway near New Orleans, which is to cost several million dollars.

George E. **Tomlinson**, Assistant Professor of Civil Engineering, University of Mississippi, has accepted a similar position at the University of Tennessee.

R. F. **Krafft**, formerly Assistant Engineer with the Great Western Power Company, of 530 Bush Street, San Francisco, Calif., is now Assistant Engineer of the Pacific Gas and Electric Company, 245 Market Street, San Francisco.

Harry Williamson, who for a number of years has been General Manager of the Arica and Tacna Ry., Tacna, Peru, has recently removed to San Salvador, Central America, where he has become General Manager of the Ferrocarril del Salvador.

Kirpal Singh has been transferred from Assistant Executive Engineer, Punjab Public Works Department at Lahore, India, to the Madagon Engineering College at Lahore.

Charles E. **Grubb**, formerly County Engineer, New Castle County, Del., has become Executive Engineer, County Highway Officials Division of the American Road Builders Association. His offices will be located in the National Press Building at Washington, D.C.

J. C. **Baxter** has resigned as Vice-President and Contract Manager of A. Guthrie & Co., Inc., to become a member of the partnership of Carey, Baxter, and Kennedy, with offices at 307 West 49th Street, New York, N.Y.

W. P. **Tooley** is now Assistant to the Chief Engineer with the Highway Construction Company. His address is 1320 West 116th Street, Cleveland, Ohio. Mr. Tooley was previously located in Dayton as Superintendent of Construction for A. P. Ziegler, Inc.

Charles J. **Ward** has been promoted from Sales Engineer to Manager of the Concrete Engineering Company, and is located at 1900 Euclid Avenue, Cleveland, Ohio.

E. W. **Phillips** has changed from Resident Engineer, Levy Court, Wilmington, Del., to Assistant County Engineer, New Castle County. His headquarters will remain in Wilmington.

E. G. **Plank**, Lieutenant, Corps of Engineers, U.S.A., who has been with the United States Marine Corps at Managua, Nicaragua, is now located at the State House, Boise, Idaho.

H. M. **Sherrard**, Assistant Chief Engineer, Main Roads Board, Sydney, Australia, will visit the United States during October, principally to attend the International Highway Congress at Washington, D.C.

J. H. **Dorroh**, formerly Dean of the School of Engineering, University of Mississippi, has become the head of the Department of Civil Engineering of the University of New Mexico, Albuquerque.

W. P. **Christe** is with Ulen and Company at Lebanon, Indiana. He was formerly Engineer with Associated General Contractors of America, at Washington, D.C.

O. W. **White**, Structural Engineer in the Planning Division of the Kimberley-Clark Corporation at Neenah, Wis., has been heretofore Assistant City Engineer of Appleton, Wis.

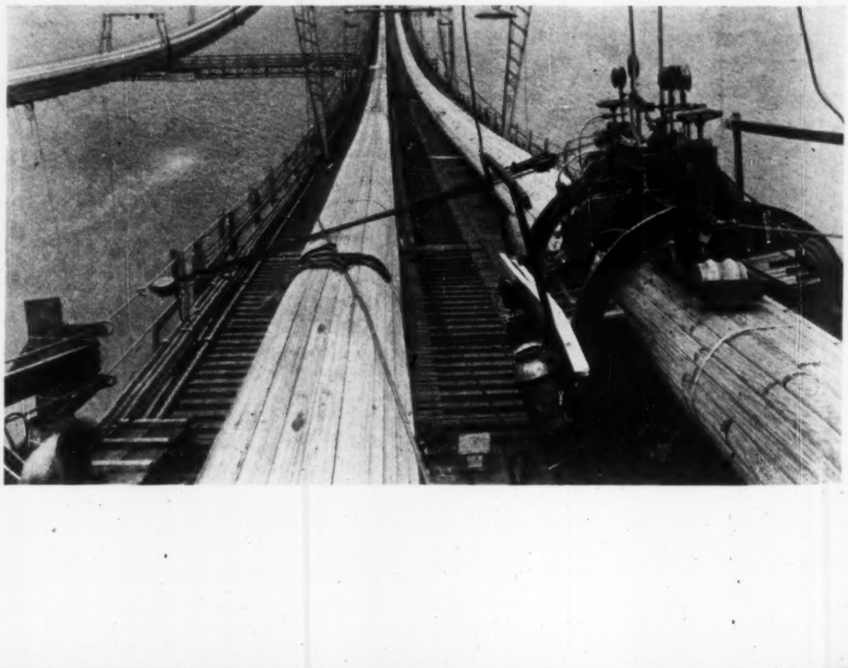
James G. **Woodburn**, John R. Freeman Traveling Scholar, 1929–1930, has recently returned from his year's travel in Europe and is now connected with the Department of Civil Engineering of the State College of Washington, at Pullman.

LeRoy W. **Van Kleeck** is now Assistant Sanitary Engineer, Connecticut Department of Health, Hartford, Conn. He has previously been with the State Department of Public Health, Boston, Mass.

PRELIMINARY COMPACTOR WORKING ON "D" CABLE OF FORT LEE BRIDGE

View taken Aug. 12, 1930, from top of New York Tower

The Fort Lee Bridge is being constructed across the Hudson River opposite 179th St. in New York City. It has a main suspension span of 3,500 ft. which is 213 ft. above high water at the center. The two towers are each 600 ft. high above water level. There are four cables, each containing 26,474 wires 0.196 in. in diameter. Each cable will be compacted to a finished diameter of 36 in. The bridge is being built by the Port of New York Authority at an estimated cost of $60,000,000 under 9 contracts. The cables are being constructed by John A. Roebling's Sons Company of Trenton, N.J., at an estimated contract price of $12,000,000.



Joel M. Jacobson has left the Fairchild Airplane Manufacturing Corp., with headquarters in Farmingdale, N.Y., to accept a position as instructor in Surveying and Aerodynamics at the Armour Institute of Technology.

Ernest J. Stocking, who has been Assistant Professor of Civil Engineering at the University of South Dakota, is now Associate Engineer, Civil Service Commission, Washington, D.C.

James H. Childs, formerly of 601 Union Bank Building, Los Angeles, is now an Associate Engineer in the Classified Service of the War Department, with headquarters at Rock Island, Ill.

Clarence A. Hart, formerly Assistant Professor of Structural Engineering, Purdue University, has resigned his position there and is now associated with the Los Angeles County Flood Control Department, Hall of Records, Los Angeles.

John C. Kohl has left his position as Inspector at the Cincinnati Union Terminal Co., located in Cincinnati, to enter the Department of Civil Engineering, at Carnegie Institute of Technology, Schenley Park, Pittsburgh.

Hans Kramer, First Lieutenant, Corps of Engineers, U.S.A., has been relieved from assignment to the 1st Engineers and from duty at Fort Du Pont, Del., and has been directed by the War Department to make a year's study of European hydraulic research methods under the John R. Freeman Traveling Scholarship, awarded to him by the American Society of Civil Engineers. Lieutenant Kramer sailed September 13, 1930.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From August 10 to September 10, 1930

Additions to Membership

Abrahams, Harry Williams. (Assoc. M., Aug. '30.) Res. Engr., California-Hawaiian Sugar Refining Corp., Connor Hotel, Napa, Calif.

Barrows, Edgar Llewellyn. (Assoc. M., July '30.) Chief Hydrographer, State Engrs. Office, Santa Fe, N. Mex.

Birke, Hakan Daniel. (Jun., July '30.) Designer, Gibbs & Hill, Pennsylvania Station, New York, N.Y.

Bowman, Don Ceylon. (M., Aug. '30.) Engr. and Contr., Hall St. and Bremen Ave., St. Louis, Mo.

Brodine, Alfred R. (Assoc. M., Aug. '30.) Engr. of Tests, City Engrs. Office, Detroit, Mich.

Buchanan, George Henry. (Assoc. M., Aug. '30.) Designer, United Engrs. & Constructors, Philadelphia, Pa.

Buetow, Walter Carl. (M., Aug. '30.) State Highway Engr., State Highway Comm., State Capitol Annex, Madison, Wis.

Burmister, Donald Martin. (Assoc. M., Aug. '30.) Instr., Civ. Eng., Columbia Univ., New York, N.Y.

Cahill, Joseph Edward. (Assoc. M., Aug. '30.) Chief of Plan Div., Bldg. Dept., City of Boston, Room 901, City Hall Annex, Boston, Mass.

Carney, James Thomas, Jr. (Jun., Aug. '30.) With Brown County Water Impvt. Dist. No. 1, 306 Citizens National Bank Bldg., Brownwood, Tex.

Davidon, Jack. (Assoc. M., June '30.) Chief Bridge Designer, State Highway Comm., 921 Bergen Ave., Jersey City, N. J.

Davis, John Douglas. (Assoc. M., Aug. '30.) Surveyman, U.S. Govt., U.S. Engrs. Office, 4400 Dauphine St., New Orleans, La.

Davis, Philip Kees. (Assoc. M., July '30.) With The Austin Co. Care, Autostroy, Nijni, Novgorod, U.S.S.R.

Dehnick, Joseph Albert. (Assoc. M., Aug. '30.) 40 East Oakland Ave., Pleasantville, N.J.

De Merse, Francis Felix. (Assoc. M., Aug. '30.) Designing Engr., Maricopa County Municipal Water Conservation Dist. No. 1, 408 Heard Bldg., Phoenix, Ariz.

DeWitt, Don Robert Smithwick. (Jun., Aug. '30.) Insp., Public Service Dept., Long Beach, Calif.

Dix, Walter Samuel. (Assoc. M., Aug. '30.) Engr., R. H. Randall & Co., Inc., 1607 Canton St., Toledo, Ohio.

Eberlin, Ralph. (M., Aug. '30.) Chief Engr., City Housing Corp., 18 East 48th St., New York, N.Y.

Erickson, Ole Peter. (M., Aug. '30.) Mech. Engr., Great Lakes Dredge & Dock Co., 104 South Michigan Ave., Chicago, Ill.

Evans, Richard Tranter. (M., Aug. '30.) Topographic Engr., U.S. Geological Survey, Zion National Park, Utah.

Fahrney, Paul Lanier. (Assoc. M., Aug. '30.) Dist. Mgr., Am. Bitumuls Co., 4200 O'Donneil St., Baltimore, Md.

French, Frank Sturgill. (Assoc. M., Aug. '30.) Asst. City Engr., City Hall, Amarillo, Tex.

Gebo, Robert Roy. (Jun., July '30.) 505 East Denny Way., Apt. 402, Seattle, Wash.

Gutiérrez-Salinas, Jorge Braulio. (Jun., June '30.) Calle Santa Fe 951, Buenos Aires, Argentine Republic.

Hamilton, George Wellington. (M., July '30.) V.P., Middle West Utilities Co., 20 North Wacker Drive, Room 2173, Chicago, Ill.

Hands, Stanley Moore. (Assoc. M., July '30.) Junior Testing Engr., State Div. of Highways Sacramento, Calif.

Hinkamp, Grant Milton. (M., Aug. '30.) V.P. and Supt., G. R. Fehr, Inc., Milwaukee, Wis.

Howard, Dudley Charles. (Assoc. M., July '30.) C.E., Magnolia Petroleum Co., Dallas, Tex.

Irwin, Luther Wesley. (Jun., June '30.) Junior C.E., Bureau of Eng., City of Los Angeles, Los Angeles, Calif.

Jewell, Howard William. (Assoc. M., Aug. '30.) 361 North Laurel Ave., Los Angeles, Calif.

Keckler, James Pumphrey. (Assoc. M., June '30.) Bridge Engr., Montgomery County, Germantown, Ohio.

Kurtossy, Roger Gabriel. (Jun., June '30.) Care, National Fireproofing Corp., 122 East 42d St., New York, N.Y.

Lamb, Arthur. (Assoc. M., July '30.) Chf. Engr., Pittsburgh Eng. Foundry & Constr. Co., Pittsburgh, Pa.

Langford, Leonard Lionel. (Jun., Aug. '30.) 250 East 237th St., New York, N.Y.

Leupold, Norbert Herman. (Jun., July '30.) Draftsman, Pacific Gas & Elec. Co., San Francisco, Calif.

Lorence, Walter Ernest. (Assoc. M., Aug. '30.) Lieut., Corps of Engrs., U.S.A.; Officer in Charge Supply and Repair Depot, Memphis Engr. Dist., Box 1017, Memphis, Tenn.

McLean, Walter Reginald. (Jun., July '30.) Lafayette, Calif.

McRee, Fitzhugh Lee. (Assoc. M., Feb. '30.) Asst. Prof., Civ. Eng., School of Eng., Texas Technological College, Lubbock, Tex.

Mansur, Everett Brown. (Assoc. M., Aug. '30.) Asst. Planning Engr., City Planning Comm., 361 City Hall, Los Angeles, Calif.

Mason, John Leslie. (Assoc. M., June '30.) Sewage Research Engr., Hardinge Co., York, Pa.

Merrill, David Howell. (Assoc. M., June '30.) Managing Sec. and Treas., Pacific Coast Bldg. Officials Conference, City Hall, Portland, Ore.

Miller, James Purdy. (Jun., Feb. '30.) Chief of Party, U.S. Engrs., 607 Postal Telegraph Bldg., Kansas City, Mo.

Miter, Harry Fancher. (M., June '30.) V.P., The Austin Co., 16112 Euclid Ave., Cleveland, Ohio.

Muhlheim, Armin. (Assoc. M., July '30.) Concrete Designer and Checker, Hydr. Dept., Elec. Bond & Share Co., New York, N.Y.

Noonon, Clifford Jay. (Jun., May '30.) Project Engr., State Highway Dept., Owosso, Mich.

Okell, Otta Clarence, Jr. (Assoc. M., Apr. '30.) With Eng. Dept., City of Glendale, Glendale, Calif.

Parlette, Lemuel Frederick. (M., Aug. '30.) Engr. of Design, Philadelphia Rapid Transit Co., Philadelphia, Pa.

Parsons, Douglas Eugene. (M., Aug. '30.) Engr., U.S. Bureau of Standards, Washington, D.C.

Pittarelli, Emilio. (Assoc. M., June '30.) Designing Engr., Corson Constr. Corp., 319 Lafayette St., New York, N.Y.

Pohmer, Albert Edward. (Assoc. M., Feb. '30.) Asst. Engr., J. Spence Howard, Bradshaw, Md.

Purcell, William Stanley. (Jun., Aug. '30.) Junior Engr., Trojan Eng. Corp., 40 Exchange Pl., New York, N.Y.

Reed, Floyd Levan. (Assoc. M., July '30.) Care, Am. Bitumuls Co., 3266 Spring Grove Ave., Cincinnati, Ohio.

Reeve, Read Driver. (Assoc. M., July '30.) Res. Constr. Engr., Pacific Gas & Elec. Co., Martell, Calif.

Rivero y Mahy, Nicolas Mariano. (Assoc. M., Aug. '30.) Engr. and Contr. (Marinello, Rojas & Rivero), Libertad 14, Ciego de Avila, Cuba.

Rollé, Sylvan David. (Jun., Aug. '30.) Office Engr., Standard Oil Co. of Pennsylvania, Philadelphia, Pa.

Rosson, Merwin. (Assoc. M., Aug. '30.) City Engr. and Street Supt., Huntington Beach, Calif.

Rounds, Harold Percival. (Assoc. M., July '30.) Structural Designer and Estimator, Ford, Bacon & Davis, 39 Broadway, New York, N.Y.

Russell, William Alton. (Assoc. M., Aug. '30.) Chief Bridge Engr., Mobile County Highway Dept., Mobile, Ala.

Ryan, Charles Patrick. (Assoc. M., Aug. '30.) Asst. City Engr., Tacoma, Wash.

Schroeder, Theodore William. (Assoc. M., May '30.) Structural Designer, Spooner & Merrill, Inc., 1506 North Wacker Drive, Chicago, Ill.

Schwartz, Morris Louis. (Assoc. M., Aug. '30.) Asst. Engr., Interstate Commerce Comm., Bureau of Valuation, Washington, D.C.

Shepard, Howard Matthew. (Assoc. M., Aug. '30.) With Erie R.R., Box 424, Greenville, Pa.

Shurlow, Kenneth Nichols. (Assoc. M., July '30.) Civ. Engr., Stevens & Wood, Inc., Jackson, Mich.

Smith, Alexander Forbes, Jr. (Assoc. M., June '30.) Asst. to Chief Constr. Engr., W. S. Barstow & Co., Inc., Reading, Pa.

Smith, Harris Alberta. (Assoc. M., Aug. '30.) Asst. Patent Attorney, The Texas Co., Box 712, Port Arthur, Tex.

SONN, GEORGE PAUL. (M., Aug. '30.) With Ford, Bacon & Davis, Inc., 39 Broadway, New York, N.Y.

STEVENS, WILLIAM GEORGE, JR. (Jun., July '30.) Engr., Philadelphia & West Chester Traction Co., Lansdowne, Pa.

TARNAY, JOSEPH. (Assoc. M., June 30.) Structural Designer, Purdy & Henderson Co., 45 East 17th St., New York, N.Y.

TUDOR, RALPH ARNOLD. (Jun., July '30.) Junior Designing Engr., Bridges, Grade III, Div. of Highways, State Dept. of Public Works, Sacramento, Calif.

VON BERGEN, HAROLD EMIL. (Jun., July '30.) Office Engr., State Engr's Office, Salem, Ore.

WALKER, GEORGE ALAN. (Assoc. M., Aug. '30.) 1128 Beach St., Flint, Mich.

WEBSTER HAROLD C. (Assoc. M., Aug. '30.) City Engr. of North Milwaukee; Cons. Engr., 216 West Water St., Milwaukee, Wis.

WHITING, WILLIAM ADDISON., (Assoc. M., June '30.) Research Engr., Am. Concrete Pipe Co., Los Angeles, Calif.

WITTE, WALTER EMIL. (M., Aug. '30.) Squad Boss (Asst. Engr.), Dept. of City Transit, Philadelphia, Pa.

WIXOM, CLINTON WOOD. (Assoc. M., Mar. '30.) Designer, United Engrs. & Constructors, Inc., Philadelphia, Pa.

YINGLING, J. MAX. (M., Aug. '30.) Dist. Engr., Austin Bridge Co., Dallas, Tex.

ZACK, SAMUEL ISADOR. (Assoc. M., June '30.) Asst. Civ. Engr., Sanitary Dist. of Chicago, Chicago, Ill.

ZIMMERMAN, HOWARD MCCORD. (Jun., Feb. '30.) Structural Engr., U.S. Govt., Treasury Dept., Washington, D.C.

MEMBERSHIP TRANSFERS

ABILDSO, HAAKON ANDREAS. (Jun. '27; Assoc. M. June '30.) Structural Steel Designer, E. I. du Pont de Nemours & Co., Room 8126, Du Pont Bldg., Wilmington, Del.

ADAMS, MADISON HILLIARD. (Jun. '26; Assoc. M., Aug. '30.) Asst. Mgr., Concrete Eng. Co., Box 1311, Houston, Tex.

BILLINGS, CHARLES NEWPORT. (Jun. '26; Assoc. M., May '30.) Asst. Div. Engr., Beaumont Div., S.P.R.R., Room 8, Grand Central Depot, Houston, Texas.

CARSWELL, CHARLES. (Jun. '23; Assoc. M., June '30.) Asst. Engr., The Port of New York Authority, 80 Eighth Ave., New York, N.Y.

DREYER, WALTER. (Assoc. M., '22; M., July '30.) Asst. Chief, Div. of Civ. Eng., Pacific Gas & Elec. Co., 245 Market St., San Francisco, Calif.

FAHY, FRANK EDWARD. (Jun. '28; Assoc. M., Aug. '30.) Structural Engr., Holabird & Root, 333 North Michigan Ave., Room 900, Chicago, Ill.

HANOVER, CLINTON DEWITT, JR. (Jun. '23; Assoc. M., Mar. '30.) Draftsman and Designer, Waddell & Hardesty 150 Broadway, Room 905, New York, N.Y.

HOYT, KENDALL KING. (Jun., '26; Assoc. M., Aug. '30.) With McGraw-Hill Publishing Co., Inc., 1252 National Press Bldg., Washington, D.C.

JENNINGS, ROBERT BOND. (Jun., '27; Assoc. M., Apr. '30.) Designing Engr., Sewer Dept., City Engr's Office, Columbus, Ohio.

MUELLER, CHESTER. (Jun., '24; Assoc. M., June '30.) Prin. Asst. Engr., Bureau of Streets, Newark, N.J.

RETZ, ROLF TORNGAARD. (Jun., '26; Assoc. M., July '30.) Structural and Hydr. Engr., Central Hudson Gas & Elec. Co., Poughkeepsie, N.Y.

SUHR, CARL JOHN. (Jun., '28; Assoc. M., Aug. '30.) Asst. Engr., Westchester County Sanitary Comm., White Plains, N.Y.

UPP, PHILIP ALFRED. (Jun. '27; Assoc. M., July '30.) Care, Ash-Howard-Needles & Tammen, 1012 Baltimore Ave., Kansas City, Mo.

WALDORF, WALLACE ASTOR. (Jun., '27; Assoc. M., July '30.) Junior Engr., Bureau of Reclamation, Ellensburg, Wash.

WALKER, WILLIAM HIGHAM. (Jun., '27; Assoc. M., June '30.) With Merritt-Chapman & Scott Corp., 17 Battery Pl., New York, N.Y.

WILSON, FRANCIS DOUGLAS. (Assoc. M., '19; M., June '30.) Dist. Engr., Chicago Dist., The Austin Co., 510 North Dearborn St., Chicago, Ill.

REINSTATEMENTS

ECKERT, OTTO ELIS, M., reinstated Sept. '30.

ENKE, GLENN LA VINE, Jun., reinstated Aug. '30.

MILLS, GUY G., Assoc. M., reinstated Aug. '30.

DEATHS

ALLEN, KENNETH. Elected M., May 2, 1888; died Sept. 7, 1930.

BLACK, ALEXANDER LESLIE. Elected M., Dec. 4, 1907; died Mar. 3, 1930.

CUMMINGS, WILLIAM WARREN. Elected M., June 7, 1899; died Apr. 4, 1930.

EDWARDS, JAMES HARVEY. Elected Jun., May 31, 1892; Assoc. M., May 2, 1894; M., May 4, 1898; died Aug. 14, 1930.

EDWARDS, RAYMOND ARDEN. Elected Jun., June 24, 1914; Assoc. M., Nov. 28, 1916; died July 13, 1930.

HARVEY, ALFRED ERNEST. Elected M., Apr. 7, 1924; died July 3, 1930.

HUCKABY, MARION COLUMBUS. Elected Jun., Oct. 9, 1917; Assoc. M., Apr. 19, 1920; M., Apr. 21, 1925; died Aug. 13, 1930.

LUDLOW, JACOB LOTT. Elected M., Mar. 3, 1897; died Aug. 18, 1930.

MCDONALD, JOHN ALEXANDER. Elected M., Feb. 5, 1890; died June 4, 1930.

PARKS, CHARLES WELLMAN. Elected M., Oct. 3, 1906; died June 25, 1930.

RODE, HANS HENRIK. Elected M., Aug. 31, 1925; died July 18, 1930.

SANO, TOJIRO. Elected M., Oct. 14, 1919; died Nov. 7, 1929.

STOLL, HAROLD DAVID. Elected Assoc. M., Sept. 10, 1923; died July 9, 1930.

WISE, JAMES GARFIELD. Elected Assoc. M., June 1, 1920; died Aug. 15, 1930.

TOTAL MEMBERSHIP AS OF SEPTEMBER 10, 1930

MEMBERS	5,764	
ASSOCIATE MEMBERS	6,115	
CORPORATE MEMBERS		11,879
HONORARY MEMBERS		17
JUNIORS		2,323
AFFILIATES		140
FELLOWS		7
TOTAL		14,366

Men and Positions Available

The items which follow are from information furnished by the Engineering Societies Employment Service. The Service is available to all members of the contributing societies. A complete statement of method of rendering the service, the location of offices, and the fees is to be found on page 87 of the 1930 Year Book of the Society. Unless otherwise noted replies should be addressed to the key number, Engineering Societies Employment Service, 51 West 39th Street, New York, N.Y.

Men Available

PROFESSOR OF CIVIL ENGINEERING, M. Am. Soc. C.E.; age 45; married; 18 years experience teaching civil engineering from instructor to head of department in Midwestern state college. Seven years of technical civil engineering. Specialities: structures, railroads, and surveying. Location, any. C-7838-308-A-1. San Francisco.

SPECIALIST IN BUILDING CONSTRUCTION, M. Am. Soc. C.E.; 20 years experience in monumental office building, and factory construction. Branch office manager and for the past six years general superintendent for one of largest contractors in Michigan. Will locate anywhere but prefers West or East coast. Best of references. C-7840.

GRADUATE CIVIL ENGINEER, Jun. Am. Soc. C.E.; age 26; six months surveying and road construction; six years estimating, detailing, and designing structural steel and miscellaneous iron work with responsible executive charge. Desires position with consulting engineer, research or teaching. Available at once. B-8213.

CIVIL ENGINEER, Assoc. M. Am. Soc. C.E.; New York State license and good contacts with all classes of contractors through western New York State; age 35; married; Cornell graduate, 1921; five years general construction experience, four years sales and promotional experience. Desires position as sales engineer with equipment company or with medium-sized contracting outfit. C-7879.

CONSTRUCTION ENGINEER, Assoc. M. Am. Soc. C.E.; 40 years of age; ten years active experience in railroad construction, grade-crossing elimination, and municipal engineering. Other construction experience and ten years as contractor's superintendent in charge of state, county, and municipal bridges, storm sewers, etc. Strong record of accomplishment. C-5705.

CIVIL ENGINEER, Assoc. M. Am. Soc. C.E.; age 38; college graduate; American citizen. Fifteen years experience: eight years abroad in design and construction of hydro-electric power plants; seven years United States, designing steel and reinforced concrete, mostly for steam power plants. Speaks Scandinavian and German. Location preferred, New York City, but right position more important than location. C-7860.

CIVIL ENGINEER, M. Am. Soc. C.E.; graduate engineer, University of Michigan; age 36; married; Protestant. Two years resident engineer water works construction; ten years in public utility work, as superintendent and general manager of water and light departments. Desires executive position in public utility or industrial field. B-4866.

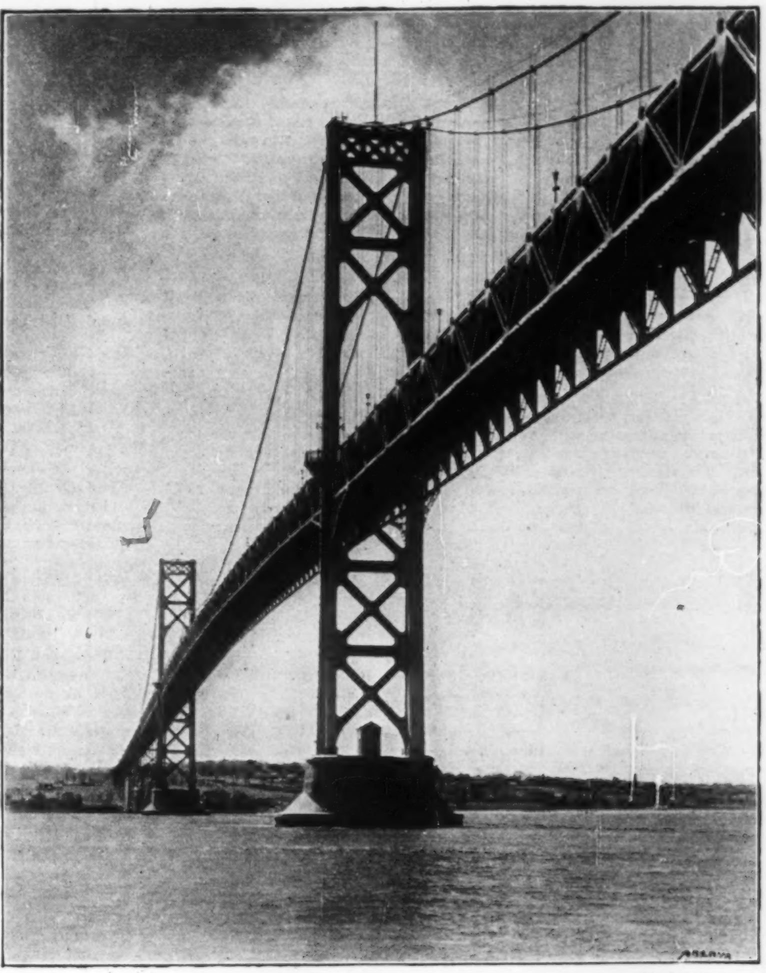
GRADUATE CIVIL ENGINEER, Assoc. M. Am. Soc. C.E.; age 36; married; 12 years varied experience in all branches of highway engineering; in municipal engineering, as engineer for several villages; in airport and hangar construction; private practice in general engineering and surveying. L.S. and P.E. Licenses, New York. Desires responsible position, Metropolitan New York preferred, but will consider any location. C-1688.

RECENT GRADUATE, Jun. Am. Soc. C.E.; experience as levelman, transitman, and inspector; computer for the New York Central. Experience in mine and on construction as workman, preceding graduation. Age 26; unmarried; excellent health and rugged physique. Qualified as junior engineer and deck officer United States Coast and Geodetic. Willing to go anywhere. C-6530.

CIVIL ENGINEER; married; age 36; graduate of Chalmers Technical Institute, Sweden. Five years experience in Sweden as surveyor and foreman on construction of hydro-electric power station and locks for 4,000-ton ships; superintendent of construction, hospital building. Five years experience in America as concrete and steel designer on industrial buildings and power plants, machine foundations, etc. C-7908.

ENGINEERING EXECUTIVE; Assoc. M. Am. Soc. C.E.; graduate in law; graduate in personnel administration; 20 years experience in construction, purchasing, promotion, investigation. Prefers position in New York City but will go elsewhere where engineering experience and legal knowledge may be combined; local representative or limited traveling. Available on short notice. B-5501.

CIVIL ENGINEER, Assoc. M. Am. Soc. C.E., age 42; married; New York license; 20 years experience in railroad location, construction, and maintenance, drainage studies, irrigation, pumping plants, industrial villages, surveys. House design and construction. Present position civil engineer on sugar estate in Cuba. Speaks Spanish. Highest references. Will go anywhere; Tropics preferred. C-7835.



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BUENOS AIRES
MONTEVIDEO

Industrial Plants - Warehouses - Railroads and Terminals - Foundations - Underpinning
Filtration and Sewage Plants - Hydro-Electric Developments - Powerhouses - Highways
River and Harbor Developments - Bridges and Bridge Piers - Mine Shafts and Tunnels

Sales Engineer, M. Am. Soc. C.E. American of wide experience and acquaintance desires position with a steel manufacturing or fabricating company, preferably in the East. Has had ample and most satisfactory experience in sales, and particularly those requiring engineering knowledge. Member of many national engineering societies. C-7790.

Civil Engineer, M. Am. Soc. C.E.; age 34; married; Cornell graduate; 13 years experience in sanitation, water supply, dams, concrete structures, subdivision, valuation of works. Designer and competent executive. Capable superintendent on construction. Will go anywhere; Southern or Southwestern location preferred. C-7963.

Graduate Civil Engineer, Jun. Am. Soc. C.E., age 30; thoroughly versed in every type of concrete design, including statically indeterminate systems with variable moment of inertia, arches, flat slabs, cellular structures; eight years responsible experience in connection with industrial developments, water power, and pumping plants. Available Nov. 1. C-5058.

Civil Engineer, Assoc. M. Am. Soc. C.E., graduate; 15 years experience in design and construction of railway and highway bridges, foundations, reinforced concrete and steel structures, industrial plants and waterfront structures. Familiar with office, field, and construction organization and conversant with promotion and financing. Now available. United States or foreign location. C-2573.

Construction Manager, technical graduate; 16 years experience on railroads, industrial buildings, power houses, schools, hospitals, water systems, and estates. Expert at organizing new work. Specialty consulting engineer on steam, water, and air systems. Can get results. Unquestionable references. Good health. Salary to suit locality, minimum $7,500. Location secondary. C-7939.

Graduate Civil Engineer, Assoc. M. Am. Soc. C.E., age 40; single; experienced in general and credit management, general and cost accounting, construction, and estimating. Six years on elevated railway reconstruction; ten years as executive with large mixed-metal manufacturer; two years organizing and managing successful contracting business specializing in waterproofing and roofing. C-6645.

Civil Engineer, Jun. Am. Soc. C.E., college graduate; age 26; total of $3^1/_2$ years experience covering surveying and factory construction, concrete inspection, material handling, and structural steel drafting. Desires either design or research work. C-7969.

Civil Engineer, M. Am. Soc. C.E.; wishes responsible position teaching mechanics, structures, or highways in non-sectarian institution; American; age 51; graduate of two universities with Ph.B., B.S., M.S., and C.E.; 20 years technical and administrative engineering experience; 5 years teaching; experienced writer and speaker; qualified personally. Location immaterial. B-5954.

RECENT BOOKS

New books, of interest to Civil Engineers, recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on pages 77 and 78 of the Year Book for 1930. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

Gestehungskosten und Verkaufspreise Elektrischer Arbeit. By Fr. Brock. Wien u. Berlin, Julius Springer, 1930. 48 pp., diagrs., 9 × 6 in., paper. 4.80 r.m.

A discussion of the cost of electrical energy, intended to present the principles that underlie rate making in a form easily understood by consumers and producers. The cost of production is first discussed and the influence of various factors shown. Rate making is then explained and various forms of tariffs are described. The influence of the power factor is given special attention.

Legal Elements of Boundaries and Adjacent Properties. By Ray Hamilton Skelton. Indianapolis, Bobbs-Merril Co., 1930. 580 pp., illus., 8 × 6 in., fabrikoid. $5.00.

The legal principles of surveying, although as important as mathematical precision, are usually less well understood by engineers. This deficiency is met by this book, which discusses the questions of law and fact that may arise, and illustrates, by numerous cases, the principles upon which courts have adjudicated them.

Measurement of Hydrogen ion Concentration. By Julius Grant. New York, Longmans, Green & Co., 1930. 159 pp., illus., diagrs., 9 × 6 in., cloth. $3.75.

The widespread importance of this subject has made a knowledge of it essential to many persons who are unversed in electrochemistry. This volume is planned to meet their needs. A simple, yet adequate account of the theoretical side of the subject is given, with detailed descriptions of the methods used both in general and in particular cases. A collection of data and numerous references are included.

Personenkraftwagen, Kraftomnibus und Lastkraftwagen in den Vereinigten Staaten von Amerika. By Emil Merkert. Berlin, Julius Springer, 1930. 356 pp., illus., 9 × 6 in., cloth. 29.50 r.m.

An examination of automobile passenger and freight transportation in the United States, with particular reference to the economic problems involved and to its effect upon the railroads. The development of motor transport, the economics of motor trucking, the economic limits of railway competition, regulation of motor traffic, motor-bus lines, highway financing, and the social, cultural, and economic effects of the automobile are considered.

Ritter der Vergangenheit und Schmiede der Zukunft. By W. Ostwald. Berlin, V.D.I. Verlag, 1930. (*Deutsches Museum. Abhandlungen und Berichte, v. 2, no. 1.*) 31 pp., illus., 8 × 6 in., paper. 1.-r.m.

Professor Ostwald's eloquent address discusses the origins of the present cultural crisis, tracing it to a present balance of power between the forces of the past and the forces of the future. The present inability of science, the youngest cultural force, to control events is ascribed to its extreme youth. The librarian of the Deutsches Museum gives a brief description of the resources and aims of its library.

Selling Transportation. Edited by Albert S. Richey. New York, American Electric Railway Association, 1930. 214 pp., illus., 9 × 6 in., cloth, $2.00.

This volume records the outstanding accomplishments of seven electric railway companies, as shown by their records submitted in competition for the Coffin award of 1928 and 1929. The work describes methods of increasing patronage and revenue, winning public cooperation, lowering costs, increasing reliability and safety, and improving management and labor relations.

Stahlbau. Edited by Otto Bondy. (*Schweisskonstruktionen, bd. 1.*) Berlin, V.D.I. Verlag, 1930. 16 pp. text and 100 plates. 12 × 9 in., cloth. 12.-r.m.

One hundred photographs illustrating the use of welding in the erection of bridges and buildings. The photographs are taken from various American and European structures and illustrate the wide variety of ways in which welds can be substituted for riveted joints. Brief descriptions accompany the plates, and references are given to fuller published accounts. The book is sponsored by the Welding Division of The Verein Deutscher Ingenieure.

Technical Arts and Sciences of the Ancients. By Albert Neuburger. Trans. by Henry L. Brose. New York, Macmillan Co., 1930. 518 pp., illus., 10 × 7 in., cloth. $10.00.

A translation of Neubergers *Die Technik de Altertums* which has for over a decade been widely read in Germany. The book brings together much information that is widely scattered, and presents it in understandable, interesting fashion. Numerous photographs and drawings illustrate the text. The whole field of mining, metallurgy, agriculture, ceramics, engineering, dyeing, etc., is treated.

Wind Bracing; The Importance of Rigidity in High Towers. By Henry V. Spurr. New York, McGraw-Hill Book Co., 1930. 132 pp. diagrs., 9 × 6 in., cloth. $3.00.

The author, chief engineer of the Purdy and Henderson Company, first describes the features of wind bracing which he believes essential. He then developes the fundamental principles of design and shows how they apply to the problems of the designer. Using a minimum of mathematics he presents methods that are sound theoretically and have proved practicable.

Zur Frage der Beanspruchung beim Dauerschlagversuch. By Siegfried Berg. (*Forschungsarbeiten, No. 331.*) Berlin, V.D.I. Verlag, 1930. 28 pp., illus., diagrs., 12 × 9 in., paper.

Dr. Berg's thorough investigation of stresses under repeated-impact tests calls attention especially to the influence of the notch effect and the damping capacity upon stress determinations. Methods are devised for determining the notch factor and the impact factor.

Introductory Economic Geology. By W. A. Tarr. N.Y., McGraw-Hill Book Co., 1930. 664 pp., illus., diagrs., maps, tables, 9 × 6 in., cloth. $5.00.

This book aims to present a general picture of the earth materials used by man. It requires little or no knowledge of geology. The work begins with a history of man's use of earth materials, and then develops the theories of the formation of the various ore deposits. Following this the various materials are discussed, with emphasis upon their mining treatment and uses. Selected references accompany each subject.

Mechanics: A Text Book for Engineers. By James E. Boyd. 2nd ed. N.Y., McGraw-Hill Book Co., 1930. 384 pp., illus., diagrs., 9 × 6 in., cloth. $3.50.

This text aims to emphasize fundamental principles, illustrate them by examples designed for that purpose, and to supply problems that will train the student in their application. Algebraic and graphical methods are developed concurrently in statics, as are work and energy, and force and acceleration, in kinetics. The new edition has been rearranged and partly rewritten, and revised by the inclusion of the British unit of work, the slug.

Mechanics for Students of Physics and Engineering. By Henry Crew and Keith K. Smith. N.Y., Macmillan Co., 1930. 371 pp., diagrs., tables, 9 × 6 in., cloth. $4.00.

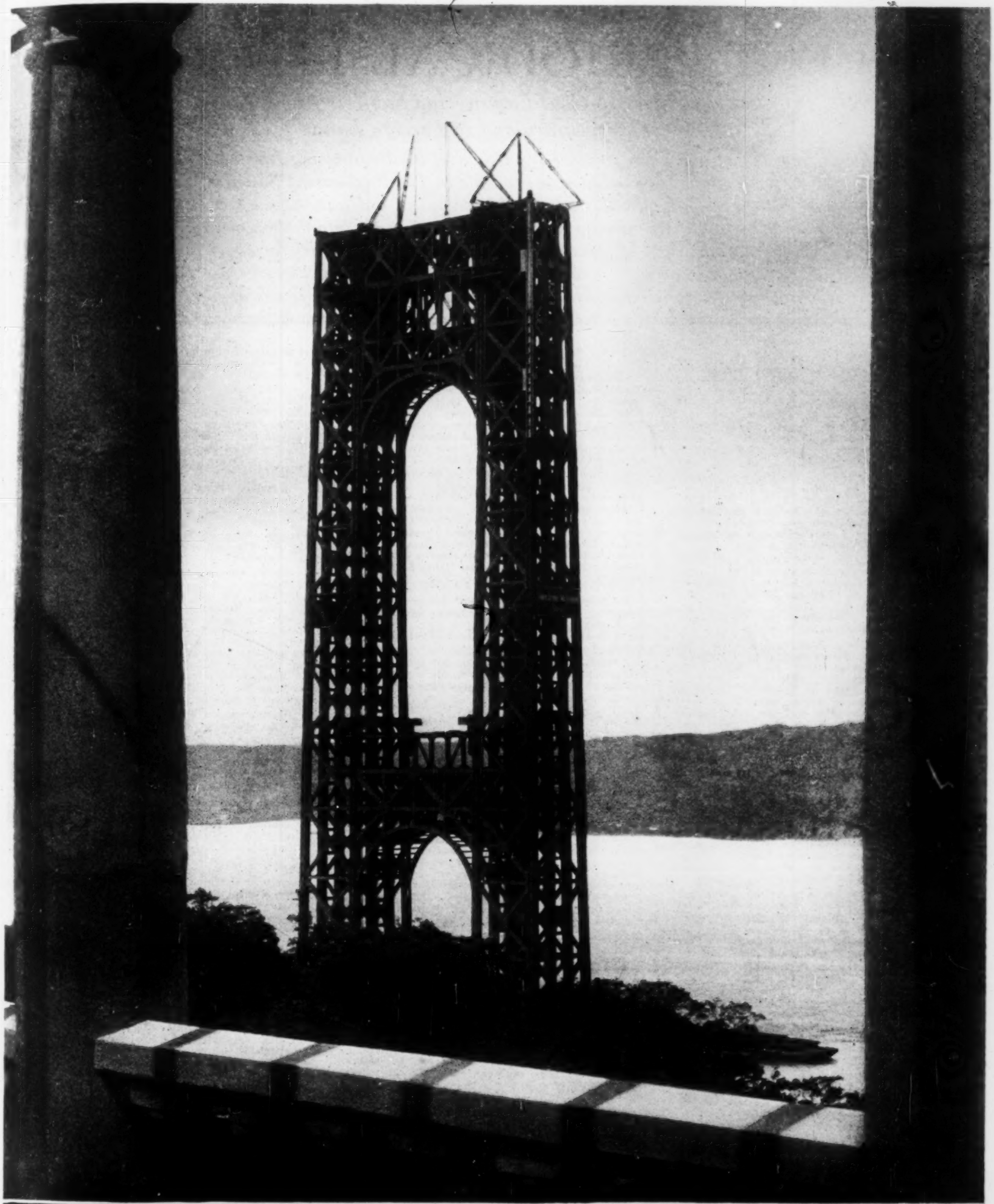
A presentation of the fundamentals of mechanics adapted to the time usually allotted to the subject in engineering colleges. Vectorial methods are used freely, and an essentially historical method of presentation adopted.

Outlines of Physical Geology. By Chester R. Longwell. N.Y., John Wiley & Sons, Inc., 1930. 376 pp., illus., 9 × 6 in., cloth. $3.00.

A briefer and more elementary course, prepared from the third edition of Part I of Pirsson's *Physical Geology*, made in 1929 by members of the Department of Geology in Yale University. Three chapters of the larger work are omitted and the others shortened.

Tables Annuelles de Constantes et Donnees Numeriques, V. 7, pt. 1–2. Compiled by Le Comité International. N.Y., McGraw-Hill Book Co., Paris, Gauthiers-Villars et Cie. 2 v., 1896 pp., diagrs., 11 × 9 in., cloth. $25.00 per set.

This annual summary of chemical, physical, and engineering facts reviews the new constants and numerical data that have appeared in any of the leading periodicals of the world. Because of its completeness and convenience, it is almost indispensable to research workers in every line. It forms, also, a supplement to the International Critical Tables. The present volumes cover the years 1925 and 1926.



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BRIDGES

Cableways, Design. Computation of Shape of Aerial Cableways Traversed by Moving Loads (Del calcolo della configurazione delle funi portanti aeree percorse da carichi mobili), G. Piazzo. *Ingegnere* (*Rome*), vol. 4, no. 5, May 1930, pp. 312–314, 1 fig. Theoretical mathematical discussion, with numerical examples illustrating use of formulas in case of supports differing in elevation.

Concrete Arch, Oregon. Oregon Highway Bridge to Be Built by Freyssinet Arch Method. *Eng. News-Rec.*, vol. 105, no. 8, Aug. 21, 1930, p. 290, 2 figs. Design of ribs and method of construction of Rogue River span of seven 230-ft. arches, to replace ferry on Pacific highways, will be in accordance with Freyssinet system.

Concrete, England. The Design and Construction of a New Canal Bridge, M. H. Limb. *Instn. Mun. and County Engrs.—Jl.* (*Lond.*), vol. 57, no. 1, July 8, 1930, pp. 21–32 and (discussion) 33–35, 12 figs. Design, construction, and architectural treatment of reinforced-concrete bridge of 40-ft. span.

Highway, Failure. Maryland Bridge Collapse Attributed to Overstressing of Damaged Members, J. E. Greiner Co. *Eng. News-Rec.*, vol. 105, no. 4, July 24, 1930, pp. 150–151, 1 fig. Abstract of report on failure of highway bridge over Monocacy River, near Frederick, Md.; verticals bent in prior accident failed under heavily loaded truck; posted weight limit exceeded; structure was two-span pin-connected through Pratt truss bridge, built in 1889; span was 153 ft. long and comprised nine 17-ft. truss panels.

Highway, Mississippi River. Seven New Mississippi River Highway Bridges. *Eng. News-Rec.*, vol. 105, no. 5, July 31, 1930, pp. 181–184, 10 figs. Features of cantilever, continuous truss, and simple truss bridges, completed or projected, in Illinois, Missouri, Mississippi, Wisconsin, and Louisiana; maximum completed bridge span is 825 ft. long; cantilever or suspension span of 1,760 ft. is proposed for bridge in New Orleans.

Steel, Cost. Costs on Steel Bridge Construction, N. A. Cain. *Contract Rec. and Eng. Rev.* (*Toronto*), vol. 44, no 29, July 16, 1930, pp. 859–861, 4 figs. Analysis of conditions attending erection of pony truss, Pratt truss, deck and viaduct type bridges; costs; accidents.

Steel, Germany. Special Steel Reduces Weight of 935-Ft. Girder Bridge. *Eng. News-Rec.*, vol. 105, no. 7, Aug. 14, 1930, p. 253, 2 figs. Design features of 935-ft. continuous deck-plate girder bridge now nearing completion over River Elbe, near Dresden, Germany, having maximum single span of 377 ft.; entire structure requires only 2,600 metric tons of special corrosion-resisting steel, made by Mittel-deutsche Stahlwerke.

Suspension, Hudson River. Spinning Four 36-In. Cables for the Fort Lee Bridge, E. W. Bowden. *Eng. News-Rec.*, vol. 105, no. 7, Aug. 14, 1930, pp. 242–248, 13 figs. Description of electrically operated plant which has spun 28,400 tons of wire in 9³/₄ months; spinning wheels travel one mile between anchorages 60 per cent faster than on any previous project by virtue of driven reels and improved tramway supports; relative arrangement of cables and footbridge, erecting footbridge section; layout of wire-spinning equipment and cable-spinning operation; spining organization; steps following completion of spinning.

BUILDINGS

Electric Welding. Structural Arc Welding, A. F. Davis. *Elec. Specifications*, vol. 2, no. 2, Aug. 1930, pp. 30–31, 2 figs. Examples of specifications, if followed in fabrication and erection of steel structures, work will go forward in rapid and efficient manner.

Much Arc Welding in New Liquid Carbon-Dioxide Plant, A. F. Davis. *Chem. and Met. Eng.*, vol. 37, no. 435, 3 figs. Arc welding has been used in no small degree for fabrication of pipe and stacks in new plant of Liquid Carbonic Corp. at Cleveland, Ohio.

Hospitals, Air Conditioning. Application of Air Conditioning to Premature Nurseries in Hospitals, C. P. Yaglou, P. Drinker, and K. D. Blackfan. *Heat. and Vent.*, vol. 27, no. 8, Aug. 1930, pp. 87–90, 3 figs. Abstract of paper presented before Am. Soc. of Heat. and Vent. Engrs., previously indexed from Heat., Piping, and Air Conditioning, July 1930.

Moving. Old 6,000 Ton Stone Building Moved 300 ft. to New Location in Pittsburgh, J. White. *Eng. News-Rec.*, vol. 105, no. 6, Aug. 7, 1930, pp. 212–214, 6 figs. Report on moving old four-story granite-block Alleghany County morgue building; holes burned through granite foundation walls to receive steel grillage; elaborate timber cribbing required over sloping and uneven ground; sketch of I-beam and H-beam grillage.

CITY AND REGIONAL PLANNING

Regional Planning, New Jersey. A New Proposal for Regional Government and Planning, R. A. Egger. *Am. City*, vol. 43, no. 2, Aug. 1930, pp. 115–116. Principal features of proposed New Jersey Regional District Act.

Zoning. Zoning Gains Through the Courts, C. Aronovici. *West. City*, vol. 6, no. 8, Aug. 1930, pp. 26–29. Review of United States laws and court decisions on zoning.

CONCRETE

Corrosion. Concrete Dissolution Phenomena. *Bauingenieur* (*Berlin*), vol. 11, no. 26, June 27, 1930, p. 451, 1 fig. General discussion of chemistry of corrosion of concrete by water poor in lime and by water containing carbonic acid, observations on existing structures.

Mixer, Motor Truck Driven. Mixing the Concrete While Travelling. *Commercial Motor* (*Lond.*), vol. 51, no. 1314, May 20, 1930, pp. 517–518, 3 figs. Interesting machine designed to effect saving for builders and constructional engineers; rotating gear is actuated by means of primary chain which conveys drive from power unit of vehicle to gear box, thence by shaft running along chassis to right-angled drive at rear; mixer drum revolves, at speed of from 10 to 20 r.p.m.

DAMS

Concrete Shrinkage. Effect of Shrinkage in Large Concrete Dams (Effet du retrait dans des grands barrages en béton), A. Renaud. *Annales des Ponts et Chaussées* (*Paris*), vol. 1, no. 2, Mar.-Apr. 1930, pp. 144–178, 12 figs. Report on formation of fissures observed during construction of Saint-Marc Dam, having gravity profile and maximum height of 44 m.; discussion of shrinkage of concrete dams and measures for presentation of fissuring, with special reference to Noetzli views on fissures, and contraction joints; notes on fissuring of dam after conclusion of construction.

Earth, Saluda River. Break Repaired at Saluda Dam. *Construction Methods*, vol. 12, no. 8, Aug. 1930, pp. 38–40, 6 figs. Gap left by slide in 11,000,000 yd. embankment closed by new earth fill; core material compacted in thin layers by rolling thoroughly after being spread dry with tractors equipped with bulldozers.

Hydraulic Fill, Saluda River, S.C. Building the Mammoth Saluda Dam, A. R. Wellwood. *Military Engr.*, vol. 22, no. 124, July-Aug. 1930, pp. 312–318, 8 figs. Dam, which is largest high earthen dam in world is semi-hydraulic fill type, consisting of two outer dikes built on dry earth dumped from wooden trestles, and an impervious core formed by sluicing earth dumped into center of dam from outer dikes; when completed, dam will contain 11,000,000 cu. yd. of earth material and have maximum width at its base of 1,150 ft.

Reservoirs, Birmingham, England. Additional Water Storage for Birmingham. *Surveyor* (*Lond.*), vol. 78, no. 2010, Aug. 1, 1930, pp. 115–117, 4 figs. Description of recently completed Bartley reservoir; city's safeguard against breakdown of Elan Aqueduct having total capacity of about 500,000,000 gal.; construction of earth embankment having maximum height of 60 ft.

Spillways, Flashboards. Tilting Slab Flashboards Provide Emergency Spillway. *Eng. News-Rec.*, vol. 105, no. 7, Aug. 14, 1930, p. 263, 1 fig. Features of concrete flashboards of spillway of Dix River dam plant of Kentucky Utilities Co., near Burgin, Ky.

FLOOD CONTROL

Levees, Hydraulic Fill. Hydraulic-Fill Levee Construction on the Mississippi, J. R. Wilbanks. *Eng. News-Rec.*, vol. 105, no. 4, July 24, 1930, pp. 131–132, 3 figs. Study of dredge design and equipment; pipe-line practice; details of flexible ball joints in discharge pipe lines. (Concluded.)

Mississippi River. The Defense Against Old Man River—IX, R. K. Tomlin. *Construction Methods*, vol. 12, no. 8, Aug. 1930, pp. 52–56, 17 figs. Building Bonnet Carré spillway; concrete pier and weir construction; steel sheet piling, aggregating 600,000 sq. ft., is driven in two lines to form water cutoffs along both sides of spillway; traveling gantry handles steel forms for piers and weirs; central plant mixed concrete is carried to job in buckets by motor trucks; cement in bulk is transferred by pneumatic conveyor system. (Continuation of serial.)

Reservoirs. Flood Storage Reservoirs (Note sur les reservoirs de crue), L. J. Tison. *Annales des Travaux Publics de Belgique* (*Paris*), vol. 83, no. 1, Feb. 1930, pp. 11–56, 39 figs. Theoretical mathematical analysis of mode of operation of flood control reservoirs and their effect on stream flow; automatic weirs.

FLOW OF FLUIDS

Flow of Liquids. On the Flow of Viscous and Plastic Materials Along an Initially Empty Long Narrow Glass Tube, G. W. S. Blair. *Jl. of Rheology*, vol. 1, no. 4, July 1930, pp. 424–428, 1 fig. Experimental study of dynamics of flow of water and starch paste, when caused to flow along initially empty glass tube of uniform cross section; from results obtained, it is concluded that any error introduced into results obtained from Bingham-Murray plastometer due to deformation of streamlines near meniscus should in general be very small. Bibliography.

Weirs, Discharge. The Effect of Surface Waves on the Discharge over Weirs, A. H. Gibson. *Water and Water Eng.* (*Lond.*), vol. 32, no. 379, July 21, 1930, p. 319. Report on experiments carried out on suppressed rectangular weir, rectangular weir with two end contractions, 90 deg. vee notch, and board-crested weir; wave disturbance increases discharge, magnitude of effect depending upon factors discussed. Abstract of paper about to be published by Instn. of Civil Engrs.

Weirs, Triangular. Calibration of Sixteen Triangular Weirs at Purdue University, F. W. Greve. *Eng. News-Rec.* vol. 105, no. 5, July 31, 1930, pp. 166–167, 5 figs. Report on experimental works in progress for more than one year in hydraulic laboratory of Purdue Engineering Experiment Station; water, oils, and sugar solutions used to determine effects of viscosity, density and surface tension upon rate of discharge; details of tank and weir; relation of head to discharge.

FOUNDATIONS

Concrete Caissons, Pile Driving. Tubes in Walls Permit Pile-Driving After Concrete Caisson Is Bottomed, R. B. Alexander. *Eng. News-Rec.*, vol. 105, no. 3, July 17, 1930, pp. 89–90, 3 figs. Caisson, which, after being sunk, permitted piles to be driven under walls as well as in dredging well spaces, was employed in building highway bridge over Brazos River near Chapel Hill, Tex.; piles were 100.5 H-column sections, 40 ft. long, and were driven through pile guide tubes and in dredging wells to depth of 25 to 30 ft. below cutting edge.

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MAXIMUM RETURN TO CLIENTS PER DOLLAR INVESTED

Dewatering. Water-Level Lowering by Means of Well Points, etc. (L'abaissement de la nappe d'eau par tubes filtrants pour les fondations en terrains aquifères), K. E. Schonnopp. *Génie Civil (Paris)*, vol. 97, no. 2, July 12, 1930, pp. 29–33, 7 figs. Report on use of special metallic tubular infiltration sounds for control of groundwater in construction of foundations; illustrations of use of this method in construction of graving dock in Antwerp, in Ymuiden locks in Holland, Grand Opera building in Berlin, etc.

Pile Driving. Pile-Driving Calculations with Notes on Driving Forces, and Ground Resistance, A. Hiley. *Structural Engr.* (*Lond.*), vol. 8, no. 8, Aug. 1930, pp. 278–288, 15 figs. Table of forces transmitted through pile, and resistance overcome in ground for given values; octagonal piles; margin of useful energy required for driving piles to given set; bearing qualities of ground; characteristics of ground resistance.

HYDRAULIC ENGINEERING

Gas Pipe Lines, Design. Design of Long Distance Gas Pipe Lines (Ein Beitrag zur Frage der Berechnung von Gasfernleitungen), Jaenicke. *Gas und Wasserfach* (*Munich*), vol. 73, no. 18, May 3, 1930, pp. 417–423, 7 figs. Collection of graphical charts and nomograms based on Biel formulas, taking into account taxes, interest, and other eonomic factors; numerical examples.

Laboratories, Switzerland. Hydraulic Laboratory of the Federal Institute of Technology of Switzerland (Versuchsanstalt fuer Wasserbau an der E.T.H.), E. Meyer-Peter. *Schweizerische Waser-u. Elektrizitaetswirtschaft.* (*Zurich*), vol. 22, no. 5, May 25, 1930, pp. 74–83, 13 figs. Description of new buildings and hydraulic and mechanical equipment totaling 1,217,000 Swiss francs.

HYDRO-ELECTRIC POWER PLANTS

Catawba River, Carolinas. How Catawba Plants Utilize Entire Flow, S. T. Henry. *Elec. World*, vol. 96, no. 2, July 12, 1930, pp. 70–73, 5 figs. Stream-flow conservation and development on vast scale, with almost complete utilization of potential power possibilities, is accomplished by storage reservoirs and hydro-electric projects of Duke Power Co. on Catawba River in Carolinas; some of water used 10 times in 1,050-ft. fall; despite extreme annual and seasonal variations in rainfall, storage equalizes flow and permits annual output of 1,400,000,000 kw-hr.

Developments, Japan. World Power Conference. *Water and Water Eng.* (*Lond.*), vol. 32, no. 379, July 21, 1930, pp. 331 and 333. Abstracts of papers by C. Mori, Japan's Hydro-Electric Power and Its Exploitation; S. Hayashi, The Utilization of Low-Head Water Power, etc. (To be continued.)

Gatineau River, Quebec. How the Cabonga Storage Reservoir Was Constructed, W. B. Hutcheson. *Contract Rec. and Eng. Rev.* (*Toronto*), vol. 44, no. 29, July 16, 1930, pp. 861–863. Description of control scheme for half-million horsepower on Gatineau River in Quebec, involving storage of 45,000,000 cu. ft. by means of dam 797 ft. long and 26 ft. high; tractor haulage with 20 ton loads.

INDUSTRIAL BUILDING

Air Conditioning. The Control of Humidity and Temperature as Applied to Manufacturing Processes and Human Comfort, W. H. Carrier. *Domestic Eng.* (*Lond.*), vol. 50, no. 7, July 1930, pp. 122–125, 1 fig. Relation of dew point to relative humidity; rate of evaporation; hygroscopic properties of materials; air conditioning and human comfort; influence of air conditions upon physical work and industrial output, also upon industrial accidents, sickness, and mortality. (Continuation of serial.)

INLAND WATERWAYS

Columbia River. The Columbia River System, G. R. Lukesh. *Military Engr.*, vol. 22, no. 12, July-Aug. 1930, pp. 328–335, 12 figs. History of discovery of Columbia River; account of improvement; potential power and possible irrigation developments.

Welland Canal. The New Welland Canal, F. L. Faurote. *Mat'ls Handling and Distribution*, vol. 4, no. 5, Aug. 1930, pp. 17–20, 78 and 80, 6 figs. General discussion of advantages of canal from distribution standpoint; brief statistical review of expenditures is given as well as plan and profile illustrations; comparison table relating to principal ship canals of world.

IRRIGATION

Cleaning of Canals. Electric Control Speeds Up Ditch Cleaning, M. M. McIntire. *Elet. World*, vol. 96, no. 4, July 26, 1930, pp. 179–180, 2 figs. Imperial Valley, Calif., taking water from Colorado River, is faced with removal of silt from more than 3,000 mi. of canals; bucket line de-silters have been tried out on laterals, but due to mechanical complications it was not until irrigation district designed and built machine of its own that satisfactory operation was accomplished.

Nile. Progress in Control of Nile for Irrigation, H. E. Babbitt. *Eng. News-Rec.*, vol. 105, no. 6, Aug. 7, 1930, pp. 206–210, 5 figs. Article based on recent visit to Egypt, gives up-to-date information on second raising of Answan Dam, which will bring storage to 4,000,000 acre-ft., also on Nag Hamadi barrage, in Upper Egypt; hydraulic laboratory at Delta barrage; plans for future.

MATERIALS TESTING

Cement Admixtures. Effect of Some Salts, Acids, and Organic Substances on Cement and Concrete (Ueber die Einwirkung einiger Salze, Saeuren und organischer Substanzen auf Zement und Beton), R. Gruen. *Zeit. fuer Angewandte Chemie* (*Berlin*), vol. 43, no. 24, June 14, 1930, pp. 496–500, 3 figs. Data on effect of chlorides of calcium, aluminum, iron and barium, hydrochloric acid, aldehydes, sugars, etc., upon time of setting, tensile and compressive strength of portland and blast-furnace cements; effect of various concentrations of phosphoric and oxalic acids upon concrete. Bibliography.

Concrete Disintegration. Properties of the Cement Bacillus and Its Development during Disintegration in Sulphate Solutions (Ueber die Eigenschaften des Zementbazillus und sein Vorkommen, etc.), A. Guttmann and F. Gille. *Tonindustrie-Zeitung* (*Berlin*), vol. 54, no. 46, June 9, 1930, pp. 759–762, 5 figs. There can be no doubt that the existence of calcium sulfoaluminate causes disintegration of concrete in contact with sulfate waters; best remedy is making dense and rich concrete.

Steel Alloys. Flow Characteristics of Special Fe-Ni-Cr Alloys and Some Steels at Elevated Temperatures, H. J. French, W. Kahlbaum, and A. A. Peterson. *U. S. Bur. of Standards—Jl. of Research*, vol. 5, no. 1, July 1930, pp. 125–183, 52 figs. Results of "creep" tests at different temperatures are given for commercial alloys of nickel, chromium, and iron, both with and without tungsten, and low chromium steels containing also tungsten, vanadium, or molybdenum, carbon steel, $3^1/_2$ per cent nickel steel and low nickel chromium steels.

MUNICIPAL ENGINEERING

Design of Streets. Profile Design of City Main Streets (Zur Querschnittsgestaltung grossstaedtischer Verkehrsstrassen), Wentzel. *Verkehrs Technik* (*Berlin*), no. 7, Feb. 14, 1930, pp. 17–20, 11 figs. Discussion of profile design with regard to street railroad track location; sketches give track arrangement and dimensions.

PORTS AND MARITIME STRUCTURES

Docks in Great Britain. Effect of Growth in Size of Cargo Ships, with Especial Reference to Liverpool, T. R. Wilton. *Engineering* (*Lond.*), vol. 130, no. 3367, July 25, 1930, pp. 121–123, and (discussion) 115–116. In discussing effect of growth of size of cargo ships on developments at Liverpool it is proposed to make comparisons over decennial periods, starting at about 1880; effect of size of cargo vessel on entrances to docks; particulars of area and tonnage for typical systems; question of type of various sheds. Paper read before Instn. of Naval Architects, July 17, 1930.

Growth of Ports. Ships and Ports—What They Mean to Each Other, K. J. Burns. *Ry. and Mar. News*, vol. 27, no. 7, July 1930, pp. 9–10. Development of ports through handling basic commodities; future of Pacific Coast depends largely on ability of port authorities to provide cargo sufficient to make calling at port an inducement to steamer lines; cooperation between port and city authorities; maintaining a ports' reputation; word of mouth publicity.

Shanghai. The Port of Shanghai. *Dock and Harbour Authority* (*Lond.*), vol. 118, no. 10, Aug. 1930, pp. 304–306, 5 figs. Industries and shipping of Shanghai depend greatly on fuel supply, which is imported; details of coal distribution; coal bunkering by hand from lighters or wharf; cargo movements in port; cargo transfer; berthing; traffic control and policing; public jetties; railways; pilotage; wharfage; possible improvements.

ROADS AND STREETS

Accelerometers, Calibration. Calibrations of Accelerometers for Use in Motor Truck Impact Tests, J. A. Buchanan and G. P. St. Clair. *Pub. Roads*, vol. 11, no. 5, July 1930, pp. 81–109 and 111, 38 figs. Report on cooperative investigation by United States Bureau of Public Roads and United States Bureau of Standards; comparison of three methods of measuring accelerations due to motor truck impact; analysis of records from displacement time apparatus, cantilever-spring contact accelerometer, and spring accelerometer; conclusions as to proper use of three methods described.

Bituminous Emulsions. Bituminous Emulsions and Cold Asphalt Road Emulsions, H. L. Bowlby. *Roads and Streets*, vol. 70, no. 8, Aug. 1930, pp. 274–276. Exposition of constitution, properties and uses of asphalt emulsions in highway field; emulsion defined; straight and reversed emulsions; quick-setting and slow-setting emulsions; limiting ratio of equal-sized particles; methods of preparing emulsions; use of emulsions in road building, capillary action. Paper presented before Boston Soc. of Engrs.

Concrete. Water Required for Concrete Paving Exclusive of Curing, E. A. Moritz. *Eng. News-Rec.*, vol. 105, no. 5, July 31, 1930, p. 172. Discussion of meter record of daily consumption for sprinkling subgrade, mixing concrete, and wetting burlap on concrete-paving operation, Shelby County, Ill.

Concrete Construction. Low-Cost Transport of Paving Materials with Tractors. *Good Roads*, vol. 73, no. 7, July 1930, pp. 260–261, 3 figs. Description of concrete-paving system developed by R. D. Baker Co. of Royal Oak, Mich.; advantages of central mixing plant; Winsor power-operated boom saves labor.

Concrete, Curing. Pavement Curing Methods Compared on Parkway Drives, W. F. Welsch. *Eng. News-Rec.*, vol. 105, no. 3, July 17, 1930, pp. 90–91, 2 figs. Calcium chloride and asphalt emulsion used in tests made by Park Commission of Westchester County, N.Y.; curing procedure; comparison of test cylinders; both methods are in writer's opinion superior to water curing method.

Construction Statistics, China. Ten Years of Road Building in China. A Statistical Study, F. Fu-an. *Assn. of Chinese and Am. Engrs.—Jl.* (*Peiping*), vol. 11, no. 6, June 1930, pp. 18–33. Historical review of road building work during past ten years; graphical representation is given; effect of road building progress upon motor car industry.

Curb Design. Improved Curb Design Increases Safety, E. H. Tatum. *Eng. News-Rec.*, vol. 105, no. 7, Aug. 14, 1930, p. 264, 1 fig. Description of curb with two batters.

Experimental, United States. Progress Report on the Connecticut Avenue Experimental Road, P. F. Critz and J. H. Eldridge. *Public Roads*, vol. 11, no. 4, June 1930, pp. 69–76 and 80, 6 figs. Maintenance and behavior of sections during 1928 and 1929; bituminous macadam (penetration) experiments; surface treatment experiments on waterbound macadam; analysis of bituminous materials used; analysis of bituminous concrete mixtures; maintenance costs and traffic; tests on vitrified brick used; results of tests of surface-treated sections indicate desirability of use of priming coat in construction.

Highway Lighting, Costs. We Should Light Our Highways, F. M. Reast. *Elec. Jl.*, vol. 27, no. 8, Aug. 1930, pp. 447–448, 1 fig. Necessity, development of program of highway lighting are generally discussed; various figures as to cost of highway lighting are given; table showing cost per mile of highway lighting installation in which lighting units were placed on alternate poles 300 ft. apart; and 4,000-lumen series lamps were used.

Highway Systems, Mexico. Coordination of Highway System with Other Transportation Systems (Coordinacion del Sistema de Caminos con los Demas Sistemas de Transporte), J. Sanchez Mejorada. *Revista Mexicana de Ingenieria y Arquitectura* (*Mexico, D. F.*), vol. 8, no. 5, June 15, 1930, pp. 271–279. Broad discussion of necessity of careful planning of highway systems, in their relation to railroads and customary traffic movement; it is stressed that, in country like Mexico, relation of pack trails to highways should also be considered, before approval of highway construction projects.

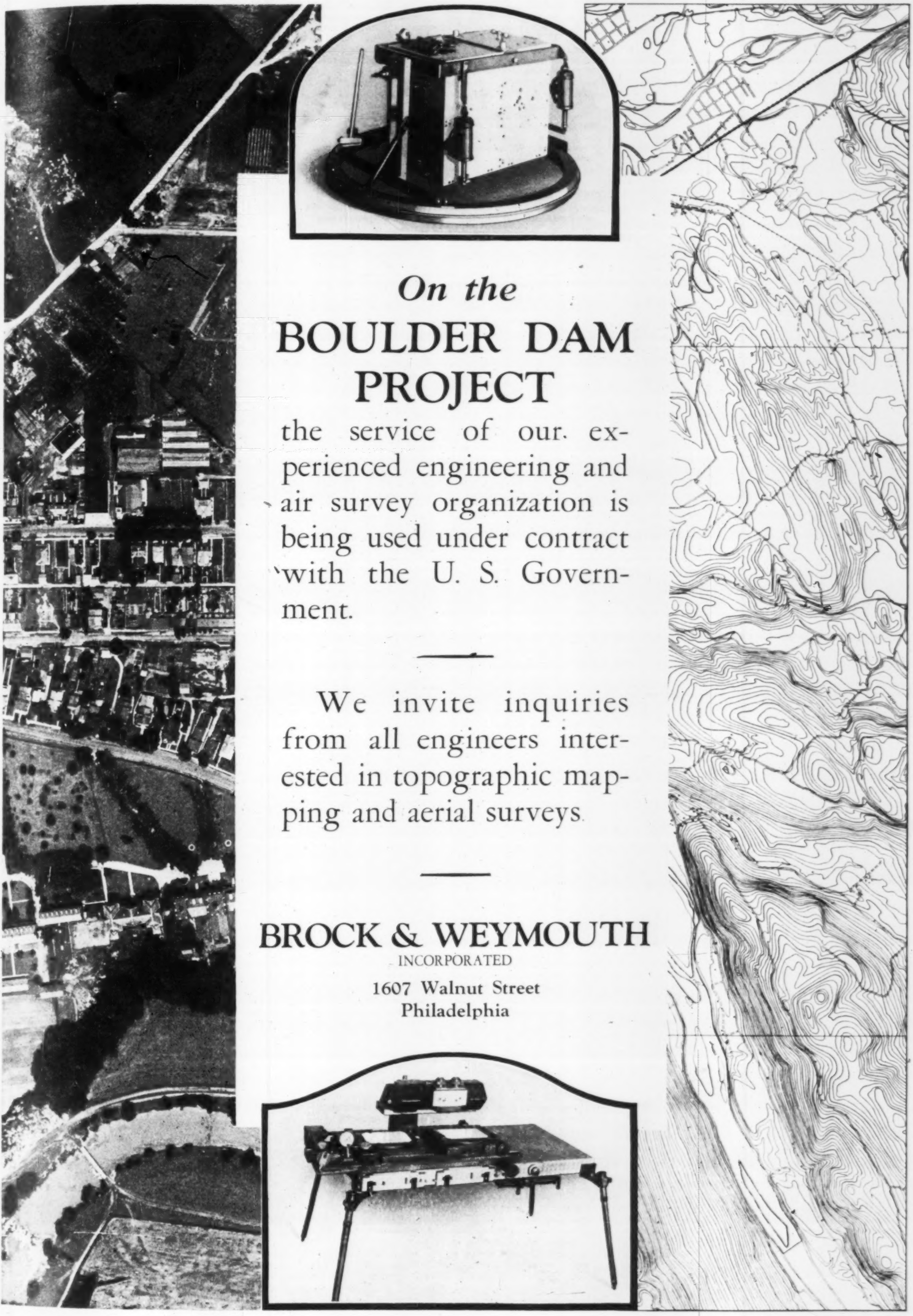
Highway Systems, Mexico. Activities of National Road Commission (Comision Nacional de Caminos). *Revista Mexicana de Ingenieria y Arquitectura* (*Mexico, D. F.*), vol. 8, no. 1, Jan. 15, 1930, pp. 3–40, 26 figs., partly on supp. plates. Statistical and descriptive review; old and modern roads; highway construction projects and progress; traffic movement; graphic diagrams and photographic illustrations.

Pavements, Asphalt. Six Varieties of Cold Laid Asphalt Pavements, A. W. Dow. *Contract Rec. and Eng. Rev.* (*Toronto*), vol. 44, no. 30, July 23, 1930, pp. 896–898. Details of types of road surfacing that have become popular and are increasing in use; asphalt amiesite type, cut-back asphalt binders, emulsified asphalt binders, colprovia type, macasphalt type.

Pavements, Bituminous Concrete. Pre-Mixed Bituminous Surfaces, A. T. Goldbeck. *Crushed Stone Jl.*, vol. 6, no. 6, June 1930, pp. 3–6, 2 figs. General discussion of premixed bituminous pavements, including: coarse-graded bituminous concrete, typified by Warrenite-Bitulithic; fine-graded bituminous concrete, such as modified Topeka, and sheet asphalt with binder course and asphalt topping; modifications of sheet-asphalt type include those which depend upon volatile liquifier; those dependent on asphalt emulsion and those dependent upon comparatively soft bitumens. Paper presented before Ohio Crushed Stone Assn., May 9, 1930.

Pavements, Concrete Construction. Water Required for Concrete Paving Exclusive of Curing, E. A. Moritz. *Eng. News-Rec.*, vol. 105, no. 5, July 31, 1930, p. 172. Discussion of meter record of daily consumption for sprinkling subgrade, mixing concrete, and wetting burlap on concrete-paving operation, Shelby County, Ill.

Roads, Joints in Concrete. Joints in Concrete Roads. *Surveyor* (*Lond.*), vol. 78, no. 2010, Aug. 1, 1930, p. 129. Results of investigation by the Ministry of Transport; cause of defects; movement at joints.



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Roads, Low Cost. Low Cost Road Future, B. E. Gray. *Roads and Streets*, vol. 70, no. 8, Aug. 1930, pp. 271–273, 3 figs. Discussion leading to the conclusion that economic considerations should give low cost road surfaces definite place in well-balanced highway plan; characteristics of satisfactory highways; ways of attacking highway problems; traffic density; types of surfacing.

State Highways, California. Western Highway Practice, C. S. Pope. *Am. Soc. Civil Engrs.—Proc.*, part 1, Aug. 1930, pp. 1278–1280, and (discussion) 1280–1282, 3 figs. Construction problems of California Division of Highways; clearing before construction; flood protection; protection against cloudbursts; sea protection; protection work at Santa Monica; control of sand dunes; protection against earthquakes; protection of highways by conserving forest cover; disadvantages of long-term financing.

Tree Preservation. Preservation of Trees a City Problem, M. L. Davey. *Can. Engr.* (*Toronto*), vol. 59, no. 5, July 29, 1930, pp. 189–191, 4 figs. Matter is of importance in municipal planning; destruction of trees during street widening and paving can be prevented if proper caution is used; growing problems for city engineers; expert attention should be given.

SEWAGE AND SEWAGE DISPOSAL

Biology of Sewage Disposal. Some Biological Notes on Sewage Disposal Processes, H. Taylor. *Surveyor* (*Lond.*), vol. 78, no. 2007, July 11, 1930, pp. 32 and 33. Purification effects of zooglea; higher forms of sewage life; organisms peculiar to settling tanks; filamentous growths and bulking life on sewage filters; sewage fungus. Abstract of paper presented to annual conference of Association of Managers of Sewage Disposal Works.

Imhoff Tanks, Design. Gas Produced in Imhoff Tanks, H. E. Babbitt and H. E. Schleng. *Can. Engr.* (*Toronto*), vol. 59, no. 5, July 29, 1930, pp. 191–192. Article previously indexed from Water Works and Sewerage, Feb. 1930.

Paper and Pulp Mills, Waste-Water Treatment. Waste-Water Problems in the Pulp and Paper Industry (Abwasserfragen auf dem Gebiete der Zellstoff und Papierindustrie), Pritzkow. *Papier-Fabrikant* (*Berlin*), vol. 28, no. 23, June 8, 1930, pp. 382–384. Brief discussion of different processes of treating waste water.

Disposal Works, Design. Design of Sewage Disposal Work, F. C. Temple. *Instn. of Engrs.* (*India*)*—Jl.*, vol. 9, May 1930, pp. 59–119 and (discussion) 120–124. Variety of methods; use of sewage data; essential functions of disposal system; various operations described; considerations regarding size of tanks; design of filters.

Plants, Akron, Ohio. Result of First Year of Operation of Akron's New Sewage Plants, T. C. Schaetzle. *Mun. Sanitation*, vol. 1, no. 7, July 1930, pp. 376–381, 6 figs. Description of old and new plants, including Imhoff tanks; operation methods; operating conditions and results during 1929; detritus equipment; trickling filters; humus tanks; sludge beds; costs; analyses of screenings, grit and sludge; plants serve population of 260,000.

Sewers, Design. Design of Combined Sewers Based on Run-off Conditions. *Eng. News-Rec.*, vol. 105, no. 8, Aug. 21, 1930 pp. 284–285, 2 figs. In studies for design of proposed relief sewers in central section of Decatur, Ill., capacity was determined by local experience and run-off curves; imperviousness of area drained by sewer; capacity of present and proposed sewers; rainfall and run-off curves; percentage of imperviousness of sewer districts; sewer capacities.

Sludge Digestion. Two Questions on Sludge Digestion Answered. *Water Works and Sewerage*, vol. 77, no. 7, July 1930, pp. 247–249, 2 figs. Author answers question as to use of pumps to circulate heating water through coils used to maintain temperature in sludge-digestion tanks; also as to pitch necessary for floor of digestion tanks in order that solids will not lodge and take up valuable space.

STRUCTURAL ENGINEERING

Concrete Arches, Plastic Flow. Plastic Flow in Concrete Arches, L. G. Straub. *Am. Soc. C.E.—Proceedings*, vol. 56, no. 6, Aug. 1930, pp. 1437–1445. Discussion by A. A. Eremin, J. Melan, F. Vogt, H. J. Gilkey, and E. Probst, of paper indexed from issue of Jan. 1930.

Concrete Chimneys, Wrecking. Five Concrete Stacks Demolished by Burning and Blasting, W. B. Hartshorn. *Eng. News-Rec.*, vol. 105, no. 7, Aug. 14, 1930, p. 264, 2 figs. Description of methods employed recently in Fort Worth in demolishing five concrete stacks, four of them 100 ft. high and one 150 ft. high, built of 14-in. concrete wall reinforced with $^3/_4$-in. sq. twisted rods, about 6 in. on centers, and lined with firebrick; exposed reinforcing bars were burned through with torch, lining and concrete were dynamited.

Empire State Building, Erection of, New York, N.Y. Planning and Control Permit Erection of 85 Stories of Steel in Six Months. *Eng. News-Rec.*, vol. 105, no. 8, Aug. 21, 1930, pp. 280–284, 9 figs. Report on construction of Empire State Building in New York City involving 57,000 tons of steel; nine derricks starting work on 425 × 198 ft. site, reduced to five above 20th floor; relay platforms necessary in hoisting steel; all hoists inside of buildings; steel supply; elevation and plan diagrams showing positions of erecting derricks and relay platforms; details of steel relay platforms.

Empire State Buildings, Structural Details of. The Empire State Building, J. L. Edwards. *Arch. Forum*, vol. 53, no. 2, Aug. 1930, pp. 241–246, 8 figs. Description of structural details of steelwork and foundations; features of typical foundation grillage, built up column sections, wind bracing connection, knee bracing, etc.

SURVEYING

Aerial Surveying. Field Use of Aerial Maps, M. S. Kennedy. *Western Flying*, vol. 8, no. 2, Aug. 1930, pp. 63–64, 1 fig. Discussion of methods of contouring on aerial photographs; notes on instruments and technique of their use.

Aerial Photography. Notes on Rectification or Correction of Aerial Photographs Taken with Optical Axes Approximately Vertical (Apuntes sobre rectification o transformacion, etc.), O. Lemberger. *Ingenieria* (*Mexico, D. F.*), vol. 4, no. 6, June 1930, pp. 241–247, 6 figs. Nadir point and radial triangulation methods are discussed. (Concluded.)

Geodetic, Alaska. First-Order Triangulation in Southeast Alaska, W. F. Reynolds. *U. S. Dept. of Commerce—Coast and Geodetic Survey—Special Pub.*, no. 164, 1930, 157 pp., 17 figs. Results for arc of first-order triangulation beginning in Tixon Entrance and extending total distance of 425 miles through Clarence Strait, Stikine Strait, Dry Strait, Frederick Sound, Stephens Passage, Lynn Canal, Chilkoot Inlet, and Taiya Inlet to Skagway, Alaska; geographic positions of 222 principal stations and 82 supplementary stations are included.

Wells, Crooked. Crooked Hole Surveying Made Simple by Syfo Clinograph. *Oil Weekly*, vol. 58, no. 6, July 25, 1930, pp. 38–39 and 80, 3 figs. Discussion of crooked holes in oil well drilling practice; advantages of surveying drill holes; acid bottle method and its defects; brief description of apparatus invented by W. E. Winn, in which liquid from upper chamber is delivered to recording chamber at desired time and is then siphoned out, leaving stain on cross-section record paper; summary of advantages of instrument.

WATER PIPE LINES

Cast-Iron Pipe, Durability of. What is the Maximum Life of Cast-Iron Water Pipe? B. B. Hodgman. *Water Works Eng.*, vol. 83, no. 16, July 30, 1930, pp. 1141–1142 and 1185, 6 figs. Report on inspection of cast-iron installation in Palace of Louis XIV still in service; author estimates life of cast-iron water pipe at 500 years or more. Excerpts from paper read before Am. Water Works Assn.

WATER PUMPING PLANTS

Diesel Operated. Economics of Waterworks Diesel Engines, R. D. Hall. *Diesel Power*, vol. 8, no. 8, Aug. 1930, pp. 408–413, 8 figs. Typical applications in water pumping stations; comparative data and costs for Diesel plants are given; cost comparison for steam, electric, and Diesel water works; chart for computing effective water hp-hr. cost and chart for computing duty of Diesel-driven pumps in B.t.u. per effective water hp-hr.

The Diesel Engine as an Economic Factor in Pumping, C. T. Baker. *Am. Water Works Assn.—Jl.*, vol. 22, no. 8, Aug. 1930, pp. 1055–1059 and (discussion) 1059–1060. General discussion of Diesel drive and pumping costs.

Pumping Stations, Equipment. The Selection and Operation of Pumping Machinery for Waterworks, F. E. F. Durham. *Water and Water Eng.* (*Lond.*), vol. 32, no. 379, July 21, 1930, pp. 308–317 and (discussion) pp. 338–345. Extracts from specification; fuel consumption; wages of operating staff; scope of contract; guaranteed fuel consumption; relative efficiencies of hand firing including economizer; consumption of coal per P.H.P. 1702 to 1929; efficiency trials of recently installed machinery; comparative costs; particulars of pumping operations of Metropolitan Water Board. (Concluded.)

WATER RESOURCES

Water Supply, Cincinnati. Development of Cincinnati's Water Supply, B. L. Baldwin. *Military Engr.*, vol. 22, no. 12, July-Aug. 1930, pp. 320–324, 7 figs. History of water-supply development; equipment of early water works; types of pumps used; details of present plan equipped with four vertical, triple expansion, crank and fly-wheel pumping engines in pump pit, each having a capacity of 30,000,000 gal. per day.

WATER TREATMENT

Chlorination, Chicago. Efficiency of Chlorination at Chicago, H. H. Gerstein. *Water Works and Sewerage*, vol. 77, no. 8, Aug. 1930, pp. 274–276, 3 figs. Description of chlorination control system and results obtained; percentage frequency of occurrence of *B. coli* in raw water at crib intakes, during 1925–1929; efficiency of chlorination; relation between *B. coli* index of raw and chlorinated water; influence of turbidity on efficiency; future of chlorination at Chicago. Paper presented before Am. Water Works Assn.

Distillation, Sea Water. Distilled Water from the Sea, B. Bryan. *Oil Bul.*, vol. 16, no. 7, July 1930, pp. 737, 739, and 741, 1 fig. Description of still and distillation system designed primarily to distill pure water from ordinary sea water, in event of emergency such as imperilment or interruption of municipal water supply; it is considered that use on large scale might enlarge and widen market for gas or fuel-oil petroleum products.

Filtration Materials. Testing of Filtering Materials (Untersuchung von Filtermaterialien), H. P. Brinkhaus. *Gesundheits-Ingenieur* (*Munich*), vol. 53, no. 26, June 28, 1930, pp. 410–412, 3 figs. Theory and laboratory methods for determining volume-weight, water-saturation volume, pore-space volume, filtration head, etc.

Filtration Plants, Experimental. Trial Filtration Plant at Ottawa, Ont., G. G. Nasmith. *Can. Engr.* (*Toronto*), vol. 59, no. 4, July 22, 1930, pp. 171–176, 2 figs. Colloiders in trial filters; floc experiences on filters; reconstruction of mixing chambers; description of original mixing chambers; filter sand; description of redesigned mixing chambers; production and settlement of floc; collection of sludge; consolidation of settled sludge; character of sludge; effect of sunshine; depth of filter sand. Paper read at 1930 Annual Convention of Amer. Water Works Assn.

Filtration Plants, Sand Shrinkage. What is the Cause of Shrinkage in Filter Sand, W. M. Wallace, R. Hulbert, and D. Feben. *Water Works Eng.*, vol. 83, no. 17, Aug. 13, 1930, pp. 1209–1210, and 1243–1244 and 1247, and (discussion) 1247–1248, 7 figs. Report on experiments at Detroit shows shrinkage in clean sand, which heretofore was not thought possible; shrinkage theory and observations leading up to it; angle of repose of sand; washing and sand shrinkage data in New York State. Excerpts from paper read before Am. Water Works Assn.

Filtration, Slow Sand. Drinking Water Purification by Slow-Sand Filtration (Beitrage zur Trinkwasserreinigung durch die langsame Sandfiltration), H. Dornedden. *Gas und Wasserfach* (*Munich*), vol. 73, no. 15, Apr. 12, 1930, pp. 340–341. Tabulated data on filtration tests made in 1924 by division of bacteriology and hygiene of Prussian Institute of Hygiene (Landesanstalt fuer Wasser, Boden und Luft-hygiene). (Concluded.)

Municipal, St. Louis, Mo. Purifying Highly Turbid River Waters, J. D. Fleming. *Can. Engr.* (*Toronto*), vol. 59, no. 6, Aug. 5, 1930, pp. 210–213. Operating experiences at Howard Bend station, St. Louis Water Works; preliminary sedimentation; basin detention; continuous basin cleaning; hopper bottom basins; mechanical basin cleaners; operating difficulties with Dorr clarifiers; sludge removal from Dorr basins; chemical dosing; excess lime treatment; prechlorination of settled water. Paper presented before annual convention of American Water Works Assn.

Plants, China. The Proposed Water Purification Plant for Nanking. *Far East. Rev.* (*Shanghai*), vol. 26, no. 6, June 1930, pp. 285–286 and 289. Features of plant with initial capacity of 10,000,000 gal. per day with provision for 10,000,000 gal. extension.

Softening, Carbonation. Results of Carbonation in Water Softening Plant, C. M. Spaulding. *Water Works Eng.*, vol. 83, no. 16, July 30, 1930, pp. 1169–1170, 1 fig. Description of practice of water works of Springfield, Ill.; method of feeding lime; carbonating equipment; effects of pH values in treated water; comparison of chemical costs; analysis of silicate scale; effect of heater on mineral constituents; sterilizing value of lime.

Taste, Odor, Color, Removal. Water Treatment for Drinking and Process Work, R. E. Gilmore. *Power Plant Eng.*, vol. 34, no. 16, Aug. 15, 1930, pp. 943–946, 4 figs. See also *South. Power Jour.*, vol. 48, no. 8, Aug. 1930, pp. 67–70 and 72, 3 figs. Methods required to remove objectionable taste, odor, color, with types of filters, softeners, and sterilizing equipment.

WATER WORKS ENGINEERING

Aqueducts, Cuba. Study of Cuban Aqueducts (Estudios Sobre Acueductos Cubanos), J. A. Cosculluela. *Revista de la Sociedad Cubana de Ingenieros* (*Havana*), vol. 22, no. 3, May-June 1930, pp. 138–150. Discussion of formula applicable to calculation for fire reserve water supply in Cuban towns of 2,000 to 50,000 inhabitants. (Continuation of serial.)

Map Records. Keeping Water Works Maps and Field Records Up to Date, E. K. Wilson. *Water Works Eng.*, vol. 83, no. 16, July 30, 1930, pp. 1143–1144 and 1177–1178. Importance of knowing location of valves in distribution system; types of maps; most serviceable scale for map; methods of locating valves; methods of indicating various constructions; filing and care of maps and tracings; valve operation records. Excerpts from paper read before Am. Water Works Assn.